The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 12. **NOVEMBER, 1910.** **No. 107.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of **5s.** per annum, such order to be countersigned by the superintendent or foreman.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

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Forthcoming Events.

NOVEMBER 6.

British Foundrymen's Association (Lancashire Branch).—"The Moulder and Chemical Analysis, with some Notes on Contraction," by Mr. F. Andrew (Oldham).

NOVEMBER 9 AND 10, AND DECEMBER 7 AND 19.

Society of Engineers (Incorporated) and the Junior Institution of Engineers.—Joint lecture on "The Law Relating to Engineering."

DECEMBER 3.

British Foundrymen's Association (Lancashire Branch).—"Imperfect Castings," by Mr. S. G. Smith (Chesterfield).

NOTES AND COMMENTS.

Business Methods in the Foundry.

While we wish to cast no slur on founders as a class with regard to their business methods, we think it is perhaps wise to occasionally direct attention to the possibility of very slack organisation outside the moulding floor and the cupola room. There is probably more danger of lax business methods being tolerated in foundry establishments than in many engineering shops and ironworks, on account of the extent to which success is dependent on technical details and the personal capacities of the workers; and there is also a danger of obscuring the commercial side of the undertaking when technical matters are placed so prominently before foundrymen's societies. We all acknowledge the increasing importance of keeping pace with the modern advances of science, and of utilising to the best advantage the innovations and discoveries which occur continually in the technical world; but the importance of strict business methods in the commercial department is not so persistently put forward. We have been placing before our readers a series of articles on business methods (one appears in this issue) which are calculated to stimulate the energies of foundry managers; and in these articles attention is drawn to various matters where better organisation is frequently badly needed in our foundry businesses. The day has gone when the manager could reckon approximately the cost of producing certain work, and then clap on a comfortable amount to cover contingencies and profit. Modern competition is increasingly having the effect of reducing the price obtainable for foundry products, and in the race for orders the prizes are to those whose equipment, organisation and operative methods allow them to quote the most favourable price to the buyer. The foundry manager to-day must not only see to the proper equipment of his works; he must arrange his wages system so as to get the best results from the men—to induce them to put forward their very best efforts in their own interest and the interest of the firm. He must organise his office so that the time of the men is duly checked, and the output from the moulding and casting floors is kept under strict supervision, and the standard properly maintained; and he must organise his costings system so as to determine as accurately as possible the cost of each particular class of casting, to assist in correctly estimating for future work. Further, a careful check must be kept on the metal stocks, and on any possible waste in melting or resulting from bad moulding; and this is in addition to the application of modern scientific methods in order to get the best results from pig-iron at the most economical rates. In fact, the position of foundry manager is no sinecure to-day, if the concern is to be run on the best and most economical lines. Many foundries are, admittedly, not run on such lines, but managers and proprietors would be well advised to give more than cursory attention to the possibility of reorganising their commercial departments with a view to increased economies. It may not always be ad-

visable to adopt the "hustling" methods which are at times advocated by business experts; such methods have often a tendency to give a bad impression among the workmen, and create the idea that extra profits are being sought at the expense of the employés. But it is always advisable to keep a sharp look-out for possible openings for improvement in organisation which will add to the efficiency of the works as a whole.

Brass Foundry Requirements.

Like the ironfounder, the brassfounder has plenty to do if he wishes to keep in touch with modern requirements. The increase in running speeds of machinery, in which brass and bronze castings play an important part, and the growing demands of the engineer as to strength and quality generally, must be properly taken into account by the brassfounder who wishes to keep his place in the field of competition. The art of alloying has now definitely passed the rule-of-thumb stage, and with the aid of the chemist and the metallographist the non-ferrous alloys have during the last few years been placed on a much higher plane than formerly. So much so, that the foundryman who imagines he can still cater for the engineer's requirements in the old way will soon find himself out of the running. There are, of course, certain classes of brass castings which do not demand particular strength or quality, but these are not the brassfounder's best work, nor the work on which successful businesses are built up. The brassfounder of the future will probably have to work to very definite specifications as regards strength, ductility, hardness, etc., and then it will be necessary to give close attention to the art, or rather science, of alloying. Competition in prices is already making it necessary to secure as little waste in melting, and to ensure as few rejected castings as possible. The cost in time and material which a "waster" represents, even though it may rank as good scrap, is an item of some considerable importance in competitive work, as few foundry managers need to be told—though it sometimes needs to be forcibly impressed on the workman. In speaking of the adoption of scientific methods, however, it must not be supposed the microscope and the services of the chemist are to replace the old individual skill of the brassfounder. They must rather rank as adjuncts to a probably higher skill (at least a more higher and more exact technical knowledge) than our fathers possessed. The problems of the day of phosphor-bronzes, manganese-brasses and bronzes, and the aluminium-copper alloys, are more complex and delicate than the problems associated with the old mixtures, and in dealing with these, as in most modern foundry matters, scientific knowledge must be combined with the skill attained in actual practice.

Specifications for Phosphor-Bronze.

The use of phosphorus as a constituent of bronze has led to numerous specifications being drawn up by various users, and these are not in all cases easy ones to work to for the foundryman. In some cases, in fact, the requirements put forward by engineers who desire bronze castings quite ignore several important features in foundry work. As an example, sometimes the user will specify for a definite amount of phosphorus to be added in the making of a certain mixture and will expect to get a predetermined amount of phosphorus in the finished casting, and definite test results. Such a specification is a most unsatisfactory one to work to, for the addition of a definite amount of phosphor-tin or phosphor-copper to a mixture will give, according to conditions, a final phosphorus content that may vary within a considerable range. The reason for this is readily appreciated when it is remembered that in most cases phosphorus does not benefit the bronze so much by reason of its presence as by its power of combining with the oxygen of the oxides in the metal, and their consequent elimination. Therefore, according to the amount of oxides in the metal, so will more or less of the phosphorus introduced be left in the metal, or inversely, be consumed in cleansing it of the oxides. The actual action of phosphorus on copper or bronze is a two-fold one; it first reduces the oxides to the metallic condition, and then the oxide of phosphorus so formed, having an acid character, combines with a further amount of metallic oxides forming phosphates, which pass into the slag. It will thus be seen that the only satisfactory way in which to get a definite phosphorus content in the finished casting is to specify the required amount and leave it to the foundryman to determine the quantity of phosphor-copper or phosphor-tin necessary to give the desired contents. If he is using good, clean ingot metal, and good, large scrap of a known composition, a much smaller amount of phosphorus will be required (if melting conditions are right) than if the materials used for the mixture are not clean and free from oxides. Usually, a small amount of phosphorus (generally ranging up to 0.1 per cent., except where hardness is required, when up to 2.0 per cent. may be present), is desired in the finished casting; but the introduction of a specified amount into the mixture is no guarantee that any definite amount will be present in the final product, unless the condition of the metal used in the mixture is first ascertained and the addition calculated accordingly.

The trouble from the brassfounder's point of view is, that if such specifications as those mentioned are followed accurately, the castings will probably not come up to requirements. This may not be the case so much with those bronzes where phosphorus is employed only as a deoxidiser, and where no more than a trace is left; but with another class of phosphor-bronze—*i.e.*, those that contain from 0.2 to 2.0 per cent. phosphorus, including those employed as bearing alloys, and in which an appreciable amount of phosphorus may be required—the matter is an important one, for these alloys are more complex in character than in the case where practically all the phosphorus is consumed. In bronze where an excess of phosphorus is used, it separates out on cooling as a phosphide of copper, and the presence of this phosphide accounts for certain of the properties of these alloys which are not possessed by ordinary bronzes. From the foregoing remarks it will be seen that founders, particularly those who produce such work as the wearing parts of machinery, will do well, in the interest of their reputations and the work they turn out, to give careful attention to the question of the additions of phosphorus necessary to give the required results, and not accept and work to slip-shod specifications which ignore the basis principle involved in the production of phosphor-bronze.

Next Convention of the American Foundrymen's Association.

We are informed by the Secretary of the American Foundrymen's Association that the next Annual Convention has been arranged for at Pittsburg, on May 23-26, 1911. Members are requested to inform the Secretary of any questions that they may wish to have discussed at the meetings, and suggest topics of interest. These will be duly considered by the new Committee on Papers, who will arrange for their presentation at the convention session.

The Education of the Foundryman.

Address before Birmingham Foundrymen,

The Birmingham Branch of the British Foundrymen's Association held the first meeting of this session on Saturday, October 22, at the Municipal Technical School, Birmingham. Mr. H. L. Reason, who as Senior Vice-President, took the chair, said that the Association was growing rapidly and becoming every day a more important body. A new Branch had been opened at Glasgow, namely, the Scottish Branch, and the Honorary Secretary of the Birmingham Branch, Mr. Hailstone, gave, on September 10 last, the first lecture of the inaugural session. There were about 250 present, and there was every indication of this new Branch becoming a very strong one. As the Birmingham Branch had been the strongest in the past, they must maintain the lead. He therefore asked each of them to get a new member during the present session.

The next business was the election of those who had been previously nominated for membership of the Branch. Mr. J. H. Dalman was elected a member, and Messrs. A. E. Baggust, R. Moore, and Hickling, associate members. There were also elected 13 associates, making an addition of 17 to the strength of the Branch.

Having read the programme for the session, the CHAIRMAN remarked that it was very gratifying to see such a splendid attendance that evening to welcome their new President, Mr. Hiorns, who, as most of them knew, had been connected with their Association from the commencement, and had always taken an active interest in the Branch. He had great pleasure in calling upon Mr. Hiorns to give his Presidential address. An abstract of the address is given herewith.

Presidential Address.

"I have first of all to express my thanks for the honour you have done me in electing me as President for the coming year. I felt very diffident in accepting it, because of my lack of practical experience in foundry work, and although I have made it my business to try and understand the nature and properties of the raw materials with which you have to deal, I cannot claim to have an extensive knowledge of the properties of castings on the large scale, and still less of the manipulative skill in producing them which can only be acquired by years of patient work in the foundry itself. Yet an onlooker often sees things which the practical worker misses, on account of the "familiarity which breeds contempt." I trust, therefore, I may be able to assist in a small way in your march towards perfection by suggestions from time to time for the solution of some of the problems which you will bring before the meetings. This address, and any advice which accompanies it, must be looked upon merely as suggestions and not in any way as dictating what ought to be done. I am well aware that there is no one rule to be applied in all cases, or one method of doing a thing, because the temperature, size, shape, metal and many other considerations require the work to be treated differently on different occasions. One thing is quite certain in this progressive age, that we cannot stand still and do the work in the same way as our forefathers did; for when a trade begins to stagnate, it is on the highroad to ruin. The Birmingham motto, "Forward," must be the watchword of the foundryman, who has to deal with a trade which is both scientific and artistic in a high degree. The rule-of-thumb method is fast becoming obsolete, what with the constant introduction of new machinery, and the exactness now demanded by the purchaser, perfect accuracy, even to a one-thousandth part of an inch being specified in some cases.

"It was with a view to assisting young foundrymen that I organised a course of instruction in the metallurgy of cast iron, so that they might at least gain an intimate knowledge of the material which forms such an essential part of the ironfounder's trade. Mr. Cook, in his Presidential address at the annual Conference last year, said: "An important requirement is the education of those who are placed under our care, the youthful students of foundry work, upon whom will rest in future the responsibility for maintaining the foundry trade of Great Britain in the premier position, where it undoubtedly stands at present." The prime advantage of scientific study is not the number of facts stored up in the mind, but the cultivation of the faculty of observation. How differently two men can look at the same thing! How very much more one can see than the other, because one has fostered his observing and reasoning faculties while the other has not! There are many master craftsmen who have never been in a science school, yet are thoroughly skilled in their departments, because they have been observant, and have reasoned out the cause of certain effects. They call themselves practical men, and so they are, but much more. They are true scientific men, because they have studied in the school of experience on true scientific lines—such men were Watt, Boulton, Arkwright, Wedgewood, Darby, Neilson, Stephenson, Murdock, and Maudslay, to name only a very few.

"We do not want in our workshops men who come to a complete standstill when an unusual difficulty occurs, who have to be dependent on the brains of others, but men who are accustomed to think and reason, men who have initiative and resource, who can grapple with an exigency and show a thoughtfulness and a will to master it. When the foundry trade can command an ample supply of such workers, there will be no talk about holding our own and of the evil of foreign competition. I can think of no better agency for the accomplishment of this end than that of this Society, which possesses enormous powers for uplifting the standard of excellence in workmanship and design.

"Let us recognise the fact that honest work, well done, is one of the greatest blessings of life. But as mechanical appliances for the easier manipulation of work multiply, there is a danger that the human interest taken in that work by the workman and pride in the results achieved may diminish. If a man finds his work irksome, he is not in harmony with his environment, he has either failed to see it in its proper light, or he has entirely missed his vocation. If we would do anything really worth the while, we must not put into it merely easy effort, languid sympathies, and conventional forms that cost nothing. We must put into it our thought, work, time, patience, self-denial, exhausting toil and sometimes sleepless nights.

"This Society may be heartily congratulated on the success of another year's work, a year in no sense inferior to past years, either in the quality of the Papers read, or in the interest and instruction gained by visits to industrial establishments.

"What are the objects of our Society? I take it

they are educational in the highest sense, because we aim at the diffusion of exact knowledge. True, we only deal with technical subjects, but each reader of a Paper is more or less an authority on the subject with which he deals, and for the most part such information is the result of close study and intimate contact with highly specialised work. Such information can be obtained in no other way, as it does not come within the scope of text-books, or for the most part, within that of technical journals, except in so far as they report proceedings of technical societies. It is a special kind of education which extends the horizon of a practical man, gives him fresh thoughts, new ideas, a more comprehensive knowledge of manufactured things and more thoroughly fits him for his special place in life.

"At the present time, we find a much greater number of technical societies than ever before. The growth of such societies has been accompanied by a decrease in the use of secret methods of manufacture; manufacturing supremacy is now decided by other factors, and it is impossible to over-estimate the importance of professional and business men assembling to interchange ideas and contributing funds for the publication of Papers for the advancement of industry. The knowledge gained by practical experience recorded in the transactions of a technical society soon finds its way into text-books for the instruction of students who will presently take our places and carry on our work.

"Mr. H. E. Field, in a Paper read before the New England Foundrymen's Association in 1906, urged that Technical Schools should give more attention to foundry subjects. He states that foundry education should be conducted in two ways: First, in the education of students who will advance into managers and engineers; and, second, in the education of moulders and apprentices. In one case, questions of foundry science and foundry progress have to be solved; in the other case the aim should be to develop the moulder into a better mechanic and a broader-minded man. I would urge the Society to take most seriously into consideration the promotion of both these kinds of foundry education, and to impress on local technical institutions the advisability of catering for foundrymen by arranging special courses of instruction, both practical and theoretical. We cannot expect Education Committees to initiate such courses of instruction, unless very strong support is forthcoming from the trade itself. It was the great demand for educated electrical engineers some few years ago that forced most technical schools to install electrical courses. In like manner, it lies with our Association to make similar demands, and to back them up with a support that will ensure success.

"Another drawback to the advancement and success of a given trade is the tendency for each manufacturer to observe an uncompromising secrecy in trade processes. There is no surer gag to expansion than for individuals to hug to themselves the delusion that their method of working is unique and that everyone else is ignorant of the same. My opinion is that there are very few real secrets in any trade, especially confined to one man or one firm. Over and over again, I have found, when such a so-called secret has been divulged, that it was a thing widely known.

"Each individual in a trade is more or less dependent on every other member, and to hide information is to a certain extent to injure the whole trade. Very often it has happened in the past in a staple trade that secretiveness has been the very means of letting the foreigner in to carry off orders while we have been jealously guarding a secret which has become obsolete."

Mr. Hiorns then briefly referred to some of the scientific investigations that have been made on cast-iron during the yast year, including those by Mr. A. Hague and Professor Turner on the action of silicon on cast iron (see page 585 of this issue); a research by Mr. H. I. Coe, on manganese in cast-iron and the volume-changes during cooling, which paper will be presented in our next issue; investigations by Mr. J. E. Stead, on the effect of sulphur and silicon on the condition of the carbon in cast-iron; the conclusions of Mr. T. Kennedy, regarding the use of sinking heads on large castings; the investigations of Dr. Carpenter and Professor Rugan, on the subject of the growth of cast-irons after repeated heatings; Mr. Adamson's application of tensile, bending, and moment of inertia tests to a number of bars of cast-iron cast from the one ladle; and Mr. D. M. Levi's classification of cast-irons and carbon steels as a series of iron and iron carbides.

At the conclusion of the address, the Chairman said that he agreed with Mr. Hiorns in the belief that they would do much better work when they knew the actual constituents of the metals and other materials which they were using. It was only by obtaining this knowledge and keeping a close watch over these things that they could hope to turn out good regular work.

Professor Turner said he was sure that they would all wish to express to Mr. Hiorns the pleasure they had experienced in listening to his address. He (the speaker) was glad to know of the start that had been made in connection with the classes at that School for those engaged in the foundry industry. It would be a pity if the local Branch of the Association did not take every advantage of the opportunities afforded in Birmingham at the present time. Mr. Hiorns had referred a great deal to the benefits to be derived from technical institutions. As one who belonged to several, he remembered how they had increased in number in recent years. He remembered the time when the Iron and Steel Institute was formed. He could not say that he took any active part in its formation, but when he was a boy there was no Iron and Steel Institute; they were supposed to be satisfied in those days with the Chemical Society. After the Iron and Steel Institute, there was formed the Physical Society, overlapping it, and, in course of time, the Institute of Mining and Metallurgy; then the Foundrymen's Association with its local branches; then there was the Birmingham Metallurgical Society and the University Metallurgical Society; then the Institute of Metals, and its recently-formed local Branch. At the conclusion of his remarks, Professor Turner said they were very much indebted to Mr. Hiorns for taking the Presidency of that Branch, and he therefore had great pleasure in moving a vote of thanks to him. (Applause.)

Mr. C. Heggie, in seconding the vote of thanks, said that Mr. Hiorns had spoken about the secrecy which was observed by some firms; but there were always two sides to every question. One could scarcely except a firm who had spent a great deal of money in research work—especially considering the present state of the trade—to throw its doors open and to give away all the knowledge which it had acquired by expensive experiments. He thought there were cases in which some secrecy was justifiable. The Association, however, had brought them many advantages. Only a few years ago, and, in some cases, even at the present day, the foundryman was thought nothing of in the works, and the chief engineer was king. At all events, he was an autocrat. But at the present day, the foundryman, in a great many cases, was on an equality with the others.

Mr. F. J. Cook supported the vote of thanks, which was heartily carried.

Bearing Metals, or Anti-Friction Alloys.

By A. Napier,

It may at first appear curious that after a number of years of research and experience with white metals and bronze anti-friction alloys respectively, the engineering world should still be sharply divided on the question of the relative merits of these two classes of bearing metals. But an examination of the metals used by different engineers for railway, machinery and other bearings confirms the opinion that the question is still an unsettled one, so far as ordinary practice is concerned. It is, of course, quite conceivable that different conditions of service would give better results from the use of bronzes, on account of their hardness, than from the more plastic white alloys. This, however, does not explain the problem, for different users employ different classes of bearing metals for practically identical purposes.

Taking the matter on a purely theoretical basis, the softer and more plastic alloys should give the greater co-efficient of friction, and the harder and firmer alloys the least. But there are other features to be borne in mind besides the actual co-efficient of friction. In practice the presence of a lubricant in the bearing has to be taken into consideration, and while a hard metal as a bearing will resist to some extent the effects of defective lubrication, unless the surfaces are in quite regular contact, heating and cutting will result. With the softer and more plastic alloys, however, the bearing will mould and accommodate itself to the shaft, and so create a perfect fit. As against the latter advantage must be set the comparatively rapid wear of plastic metals, should the lubrication be at all defective. The contention of Charpy to the effect that if a journal is well adjusted, the friction is practically the same, regardless of the metals in contact, and depends on the lubricant, is probably correct; for in a perfect bearing the metals should never come into actual contact with each other, but should always be separated by a film of lubricant which takes the friction. But in practice, bearings are not always accurately adjusted, and lubricating systems are not always absolutely perfect. Accordingly, the nature of the metal used then comes into question as affecting the heating and cutting of the bearings.

The combination of hardness and plasticity—at first sight a contradictory requirement—which gives the best bearing properties, is obtained by alloying metals which in solidifying will form a structure composed of hard grains embedded in a plastic matrix. Such a structure, while giving a hard wearing face, allows any irregularity in the bearing to be met, owing to the plasticity of the matrix containing the hard grains.

The study of these requirements has resulted in the production of a great number of so-called anti-friction alloys, of compositions as varied as the uses to which the metals are put. Some of these have proved of considerable use, but many of them have been simply the result of guess work, and have given no advantage over those previously used. While the author holds the opinion that the bronzes are rather inferior to white metals for bearings, they are so largely used, particularly for railway carriage bearings on account of the great weight to be borne, that some notes on their qualities and composition will not be out of place.

Bronzes for Bearings.

Alloys of copper and tin, with sometimes phosphorus and other metals in small quantities, are largely used for bearing bronzes. If more than 9 per cent. of tin is present the hard compound $SnCu_3$ separates out, and when phosphorus is present a hard compound PCu_3 separates out and forms a eutectic with the $SnCu_3$. While these alloys consist of hard particles embedded in a softer matrix, the matrix is much harder than in the case of the tin and lead alloys, being a solid solution of tin in copper. The compressive strength is great, but the plasticity is not equal to that of some of the anti-friction metals proper. The composition of these bronzes ranges from about 80 to 89.5 per cent. copper, 19 to 9 per cent. tin, with small quantities (under 1 per cent.) of lead, zinc, antimony and phosphorus. Some typical examples are as follows:—Copper 86 per cent., tin 14 per cent.—an alloy used for locomotive bearings; copper, 82 per cent., tin 18 per cent.—used for car bearings; copper, 84.83 per cent., tin 13.6 per cent., phosphorus, 0.46 per cent., lead, 0.38 per cent., antimony, 0.13 per cent., zinc, 0.59 per cent.—a phosphor-bronze used for anti-frictional work.

What are known as plastic bronzes contain relatively large quantities of lead, and are much favoured for anti-frictional uses. In fact, these three metals (copper, tin and lead) form most of the standard bearing bronzes. The lead may be present in amounts up to 15 per cent. or more, and does not alloy with the copper, but separates out in the from of globules distributed through the alloy. It increases the plasticity, but unlike other anti-friction metals, the matrix in the case of such bronzes is hard, and the soft particles are embedded therein. The presence of a good amount of lead, too, renders the bearing less liable to heating, while the rate of wear is accordingly diminished. The rate of wear appears to diminish with the increase of lead up to a certain point; that is to say, as the plasticity increases and the compressive strength diminishes, so does the rate of wear decrease. In the case of a hard alloy, should the lubrication of the bearing be defective, the tendency would be for the portions of the metal rich in copper to adhere to the shaft and cause a considerable increase in friction, with a corresponding heating of the bearing. Some typical alloys of the copper-tin-lead series are as follows:—

Copper. Per cent.		Tin. Per cent.		Lead. Per cent.		Phosphorus. Per cent.
80.8	...	4 6	...	4.6	...	—
80.2	...	5.2	...	14.6	...	—
79.7	...	10.0	...	9.6	...	0.7
77.0	...	8.0	...	15.0	...	—
68.0	...	5.0	...	26 0	...	—

According to one investigator, the best alloy for general purposes is Cu. 64 per cent., Sn. 5 per cent., and Pb. 30 per cent., with 1 per cent. of nickel added. The exact action of nickel is very difficult to determine, but it is claimed that by its use a larger amount of lead can be employed without causing segregation. Certain it is that very good alloys containing as much as 30 per cent. lead are frequently made by the addition of 1 per cent. of nickel.

White Anti-Friction Alloys.

Perhaps the best known alloys for bearing purposes are those which are classed as Babbitt's metal, which name is now applied generally to the alloys of tin, copper and antimony in varying quantities. The original Babbitt's metal had a composition of tin 88.9 per cent., copper 3.5 per cent., and antimony 7.4 per cent., but now this composition varies, according to the maker, from about 60 per cent. tin, 20 per cent. copper and 20 per cent. antimony, to 90 per cent.

tin, 4 per cent. copper and 6 per cent. antimony. In fact, were Babbitt alive to-day, while he might experience some pride at the general application of his name, he would probably be very surprised at some of the alloys that pass as Babbitt's metals. The original formula for preparing his metal was to melt separately 4 parts copper, 12 parts tin and 8 parts antimony, then after fusion to add 12 parts of tin, this mixture constituting the hardening. One part of this hardening was then melted with two parts of tin, giving the composition stated.

As examples of the tin-copper-antimony alloys now used as antifriction metals may be taken the following, which are quoted from various sources:—

Tin. Per cent.		Copper. Per cent.		Antimony. Per cent.
86	...	4	...	8
90	...	2	...	8
87	...	6	...	7
83	...	6	...	11
82	...	6	...	12
80	...	10	...	10
67	...	22	...	12
67	...	11	...	22

All the foregoing alloys are used for bearings, in most instances for railroad carriage and similar work.

Before passing to the other white metals, it may be of interest to note that the addition of nickel to Babbitt's metal has at times been recommended for the purpose of increasing its hardness and improving the wearing qualities; but it has yet to be proved that the latter effect is obtained. A more satisfactory effect as regards increased hardness is obtained by the use of larger quantities of copper and antimony.

A class of anti-friction alloy which is very popular for various work, largely on account of the low price, consists of lead, tin and antimony. If brittleness is to be avoided with these alloys the antimony should not exceed 18 per cent., though in some cases as high as 25 per cent. has been used. As an instance of a high antimony content may be taken an alloy used on some of the Italian railroads, the composition being:—Lead, 37 per cent., tin, 38 per cent., antimony, 25 per cent. Another railroad bearing alloy quoted by Ledebur contained:—Lead, 60 per cent., tin, 20 per cent., antimony, 20 per cent. Most alloys of this class, however, contain less than 18 per cent. antimony.

Of the zinc-antimony-tin alloys the only useful ones for antifriction purposes are those which contain an excess of zinc. In these alloys, zinc and antimony unite to form a hard compound, which is the first to solidify. As these alloys have a great compressive strength, they are very useful for certain purposes where that quality is required, as in the case of rock breakers and similar machinery. About 80 per cent. zinc, 10 per cent. antimony and 10 per cent. tin probably gives one of the most useful of this class of metals.

There are, as already indicated, a number of other white metal alloys being applied to anti-frictional purposes, but among those mentioned here will be found those most applicable to bearings of different descriptions—whether railroad locomotive and carriage bearings, or similar parts for industrial machinery.

General Remarks.

While it is very important to employ the best possible alloy for lining bearings, particularly where a great weight has to carried, it is equally if not more important to see that the bearing is properly fitted and lubricated. For no metal will long stand defective lubrication, and while slight irregularities may be accommodated in a plastic metal, bad fitting is certainly not conducive to long life for the bearing.

A feature in the casting of the metals under discussion that is of some considerable importance, is the temperature at which they are poured, and the rate of cooling. The rate of cooling governs the crystallisation, and may so modify or exaggerate a particular tendency in crystallisation in a certain alloy as to give quite a different metal as regards working qualities. It is impossible to lay down any rule for the control of this matter, but as a general fact it may be said that too slow cooling of the alloy allows bad crystallisation to take place. Cooling too quickly is also detrimental in some cases, but the usual fault is the reverse. The first cause of heating in bearings is, of course, the absence of the lubricant which should be between the metals, but heating will be more or less severe with the same alloy according to whether or not it has been subject to defective crystallisation, giving sharp cutting crystals. This, as just mentioned, results from the cooling being either too quick or too slow, though generally the latter. Dross or scum in the metal, also, will lead to heating, while if too great an amount of one metal be put into the mixture or the proportions be wrong, segregation of the metals may result, giving another cause of heating. As in most foundry matters, it is difficult to give book instruction that will serve as well as practical experience, but the foregoing notes may prove helpful in some quarters where attention is confined, perhaps, to only one anti-friction alloy.

Some Common Defects Occurring in Alloys.*

By Cecil H. Desch.

After references to the defective state of our knowledge of the "diseases" of non-ferrous metals and alloys, as compared with that possessed by manufacturers and users of iron and steel, the importance of the equilibrium diagram as a guide in undertaking investigations of this kind is emphasised, and some of its limitations are mentioned. Some of the principal defects observed in non-ferrous alloys are then briefly reviewed, as a basis for discussion. The original casting may be defective owing to (1) sponginess; (2) brittleness, due to (*a*) oxides or dross, (*b*) intercrystalline metal or eutectic; (3) inequality of composition, due to (*a*) imperfect mixing, (*b*) separation by gravity, (*c*) segregation in the mould; or (4) excessively coarse structure, due to casting at too high a temperature. Other defects arise in the alloy after casting, and are caused by (5) wrong thermal treatment, such as (*a*) quenching from a high temperature, (*b*) annealing too long or at too high a temperature, (*c*) burning, (*d*) unequal thermal treatment of different parts. A sixth class of defects is due to polymorphic change. Defects due to mechanical causes include (7) shrinkage cracks; and (8) molecular changes induced by mechanical strain, of which the most important are (*a*) season-cracks, fire-cracks, and the so-called "strain disease" observed in spun and other severely strained metals, (*b*) chilling-cracks, and (*c*) cracking during hot-working. Corrosion and mechanical erosion are included among the other "diseases" occurring during use, the former being at present under investigation by a special committee of the Institute, whilst the latter is of special interest at present in connection with the behaviour of high-speed propellers.

THE annual meeting of the members of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., on January 17 and 18, 1911. At this meeting a number of interesting papers will be presented, together with the "Preliminary Report to the Corrosion Committee."

* Abstract of Paper read before the Institute of Metals, 1910.

The Influence of Silicon on Pure Cast Iron.*

By Arthur Hague, M.Sc.

The chief object of the following research was to examine the effect of varying proportions of silicon on the volume and temperature changes, during the cooling, of a pure high-carbon iron alloy. For the systematic study of the volume changes during the cooling of cast iron, we are mainly indebted to Professor T. Turner† and Mr. J. W. Keep (U.S.A.).‡ Professor T. Turner correlated the volume changes with the temperature arrests on cooling, and the present research is a continuation of his work on exactly similar lines.

The same extensometer was used to magnify the volume changes; the magnifying factor being 32.5, which conveyed an expansion of $\frac{1}{100}$ th-in. on a 12-in. bar into a motion of 0.83 centimetres of a pointer on a scale. The only modification was in the substitution of a 1-in. square test bar for the ½-in. square bar which was used in the original experiments. The original size of bar was thought to give too little

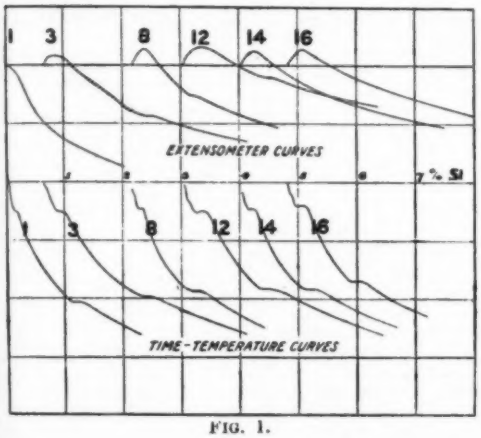


FIG. 1.

metal, and consequently too rapid cooling, for accurate temperature observations. It was further decided to alter the cross-section of the 12-in. portion from square to circular; this was with a view to convenience in subsequent mechanical tests. The base materials employed for forming the series of bars were :—

1.—A very Pure American Washed Iron. Analysis.		2.—A Pure 50 per cent. Ferro-silicon. Analysis.	
	Per cent.		Per cent.
Total carbon ...	3.06	Silicon	48.86
Graphitic carbon ...	0.17	Aluminium ...	0.01
Combined carbon ...	2.89	Calcium	0.16
Silicon	0.03	Magnesium ...	0.09
Phosphorus	trace	Copper	0.10
Sulphur	trace		
Manganese	nil.		

Some difficulty was experienced in obtaining a sufficiently pure ferro-silicon, as aluminium to the amount of 2.3 per cent. is fairly common in most varieties analysed. The weight of the test bars was 4½ lbs., and to allow plenty of margin for gate metal each cast was calculated to require 5½ lbs. of metal.

Readings of the extensometer and galvanometer were taken at regular time intervals, from the moment when the metal had completely filled the gate. A clock constructed to ring a bell every ten seconds gave the time interval usually employed; but at the commencement of each test, in order to record the beginning of solidification, it was desirable to

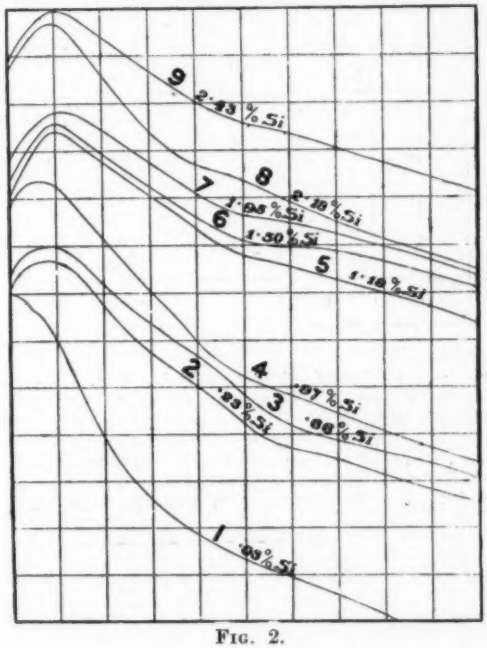


FIG. 2.

read at every five seconds, and it was found that with practice this could readily be done.

The thermo-couple of platinum and platinum-rhodium was calibrated at frequent intervals by freezing-point determinations of pure copper, silver, aluminium, and lead, was protected up to the bare twisted junction by a clay tube, and was so fixed into the prepared sand mould that the last twist, or in other words, the real hot junction, was in the exact centre of the bar. The holes in the mould end of the protecting tube were carefully plugged with fireclay to prevent the metal running back and short-circuiting the couple. In melting, the pots were carefully covered with a lid to keep out fragments of coke, and, with due precautions, it was found that practically no sulphur entered into the metal.

A quantity of charcoal and of carbon was placed in the pot with each charge in order to keep the carbon as high as possible. About 0.4 per cent. carbon was, however, lost during the melting and raising to pouring heat.

* Presented, with an introduction by Professor T. Turner, at the Autumn Meeting of the Iron and Steel Institute.

† "Journal of the Iron and Steel Institute," 1906, No. I. p. 48. "Volume and Temperature Changes during the Cooling of Cast Iron."

‡ *Ibid.*, 1895, No. II.

A series of bars was contemplated with the silicon, rising by ½ per cents. from 0 up to 5 per cent. silicon. For the first bar of the series it was desirable to keep the silicon as low as possible, and for this purpose a sample of the washed iron was melted in a brasqued crucible, so that the risk of silicon entering from the

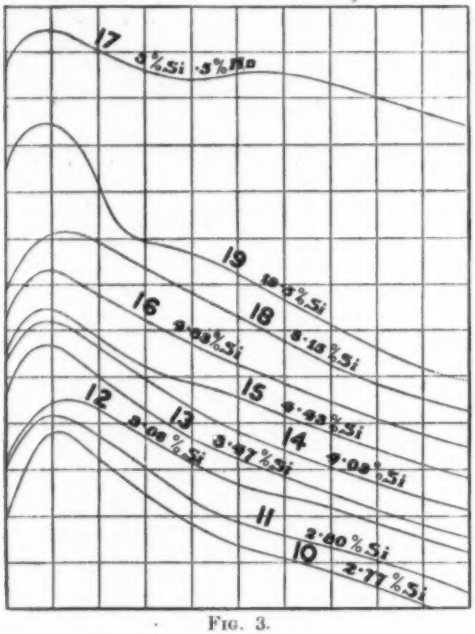


FIG. 3.

pot was minimised. The sample bar (No. 1, Fig. 8) shows no gain in silicon from the original sample of washed iron. When it was attempted to add the silicon to the washed iron by the use of the 50 per cent. ferro-silicon, it was found that only a relatively small proportion of the silicon entered into the iron, and most of the ferro-silicon was found in the pot

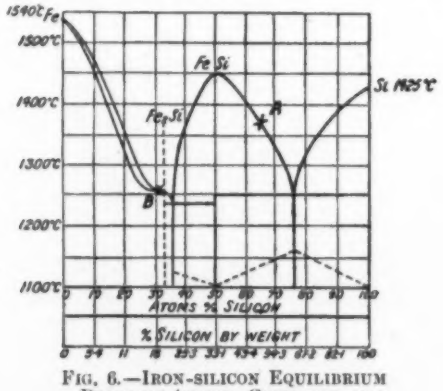


FIG. 6.—IRON-SILICON EQUILIBRIUM DIAGRAM (AFTER GUERTLER AND TAMMANN).

after pouring, and in lumps which were honeycombed or oxidised to the core. Many attempts were made to get the silicon to enter, but with little success. The iron containing 3 per cent. of carbon did not seem to have any appreciable solvent action on the ferro-silicon, and the latter was rapidly oxidised—possibly indirectly by carbon dioxide.

One reason for the difficulty encountered in getting the ferro-silicon into the iron may be deduced from the diagram due to Guertler and Tammann (Fig. 6). The melting-point of a 50 per cent. alloy is shown by the point "A" on the liquidus. To take up more iron it is therefore necessary to surmount the maximum melting-point due to the compound FeSi, which melts at the high temperature of 1,450 degrees C. The main reason however is, in the author's opinion, that the carbon in the washed iron prevented the silicon from entering. This view was confirmed by subsequent work on the materials when it was found that by diluting the washed iron with a quantity of pure over-blown Bessemer steel, in such proportion that the carbon would be about 1 per cent., the ferro-silicon was readily taken up to form an alloy containing about 20 per cent. silicon. The "temper" alloys were made in this way, one of 15.75 per cent. silicon and another of 19.5 per cent. silicon, and these alloys were subsequently used for adding the necessary silicon in making the series of bars. Even when the carbon was as low as 1 per cent. in these ferro-silicons there were many shrink holes filled with spongy graphite.

A test bar of the 19.5 per cent. silicon was cast, but only the extensometer curve is available (Bar 19,

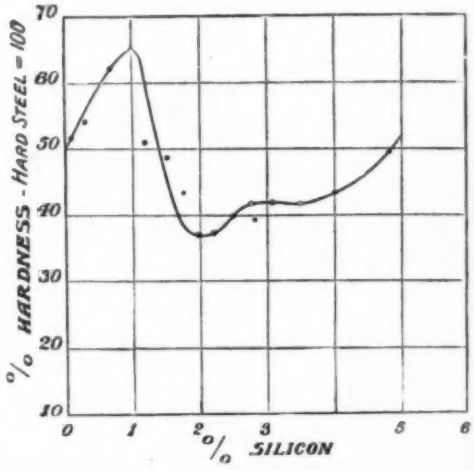


FIG. 7.

Fig. 3), as the bare couple wire was almost immediately dissolved in the molten alloy. The bar shows a considerable initial expansion, followed by a very rapid contraction, a retardation in contraction, and again a further rapid contraction. The final contraction of the cold bar was very marked, being ⅜ in. on 12 in. Sixteen cast bars are included in the series, and the carbon and silicon contents, together with the temperature arrests on cooling, are tabulated in Table I.

The 12-in. round bar was carefully detached for future mechanical testing. Each bar was analysed for sulphur, phosphorus, and manganese, in addition to the analysis for carbon and silicon. In no case was more than a trace of phosphorus or sulphur obtained, and manganese in every case was absent. Two additional bars, with higher silicon, were cast and analysed for silicon only. A further special bar with 0.5 per cent. of manganese was also prepared and examined.

An attempt was made to give a definite value to the traces of phosphorus and sulphur present, with the result that on a 10-gramme sample of Bar 6 the phos-

phorus found was 0.002 per cent. and the sulphur 0.004 per cent.

The bars were tested for hardness by means of the scleroscope, and the results are shown plotted in Fig. 7. Most of the bars were examined microscopically, and some typical photomicrographs are given (see Figs. 8 to 23).

TABLE I.—*Silicon and Carbon Contents and Temperature Arrests.*

No. of Bar.	Fracture.	Silicon.	Total Carbon.	Graphitic Carbon.	Combined Carbon (by diff.).	Temperature Arrests.			Other Arrests.
						H_1 (°C).	H_2 (°C).	H_3 (°C).	
		Per Cent.	Per Cent.	Per Cent.	Per Cent.				
1	White	0·03	2·71	0·16	2·55	1245	1138	700	Indications in most cooling curves between the temperatures 800° C. to 900° C. of a slight arrest corresponding to bend out in extensometer curve before the bending corresponding to H_3.
2	,,	0·23	2·61	0·17	2·44	1217	1138	714	
3	,,	0·66	2·95	0·13	2·82	1244	1136	726	
4	,,	0·97	2·56	0·23	2·33	1247	1136	730	
5	Grey	1·19	2·70	1·32	1·38	1244	1136	734	
6	,,	1·50	2·48	1·29	1·19	1230	1137	739	
7	,,	1·95	2·47	1·50	0·97	1246	1141	746	
8	,,	2·18	2·54	1·50	1·04	1213	1146	752	
9	,,	2·43	2·54	1·51	1·03	1243	1146	752	
10	,,	2·77	2·67	1·47	1·20	1238	1148	764	
11	,,	2·80	2·51	1·48	1·03	1245	1153	764	
12	,,	3·06	2·77	1·93	0·84	1202	1154	774	
13	,,	3·47	2·79	1·87	0·92	1195	1158	780	
14	,,	4·03	2·34	1·55	0·79	1220	1160	774	
15	,,	4·43	2·41	1·75	0·66	1201	1160	786	
16	,,	4·83	2·26	1·62	0·64	1211	1161	796	
17	,,	3·00	2·62	2·40	0·22	1210	1146	687	
Manganese = 0·5 p. ct.									

Summary of Results.

Volume and Temperature Changes.—Some typical time-temperature and extensometer curves are shown in Fig. 1, while the extensometer curves of the series are shown in order of increasing percentages of silicon in Figs. 2 and 3. The whole of the cooling curves have been collected together and drawn as inverse rate curves in Figs. 4 and 5.

Three general arrests are obtained in cooling:—

1st Arrest H_1.—Indicating commencement of solidification. This is very liable to supercooling inaccuracies, and in some cases was not definitely shown.

2nd Arrest H_2.—A very definite arrest, indicating solidification of eutectic.

3rd Arrest H_3.—Also very definite, and corresponding to the recalescence point or pearlitic point.

As shown by Turner, a pure white iron gives no initial expansion or solidification, but only a slight lag in the normal contraction, which he correlates with the "well-known pasty stage" in the solidification of

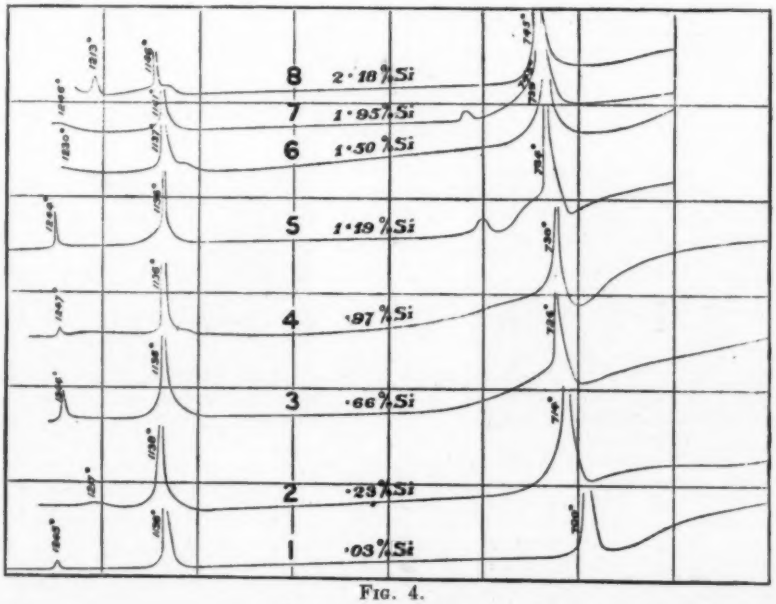


FIG. 4.

white iron. There is also a slight bend or retardation in the contraction of pure white iron, corresponding to the lowest arrest H_2.

When only a relatively small amount of silicon is present there is a distinct expansion at solidification, and in the whole of the bars of the series this expansion occurs during the arrest H_1, and persists till all the metal is solid; that is, till the end of the eutectic arrest H_2. After the metal has completely solidified it commences to contract, and this contraction is normal till the third arrest H_3, when a more or less pronounced retardation in the contraction occurs. With a relatively small amount of silicon present the bend at H_3 is much more marked than in the pure white iron.

It is of interest to note that though Bar 4 with 0.97 per cent. silicon was quite white, Bar 5 with 1.19 per cent. was grey. There appears to be a critical point under the conditions of these tests at about 1 per cent. silicon. This sudden change, as shown by the appearance of the fracture, the microstructure, and the amount of graphitic carbon, is also markedly shown in the magnitude of the solidifying expansion. This expansion rises to a maximum between 1.2 to 1.5 per cent. silicon, and over this range the photomicrographs show the largest size primary graphite flakes.

After this maximum, as the silicon increases, the initial expansion on solidification gradually decreases if the high expansion of Bar 10, where the silicon is 2.77 per cent., be rejected as abnormal. A fairly sound reason for attaching less importance to this high value is given by the very different results of Bar 11. With an almost identical proportion of silicon, namely 2.80 per cent., this bar gives a considerably lower maximum expansion. The expansion is not directly proportionate merely to the amount of graphite present, as the graphite content steadily rises, as the silicon increases, from 1.25 to 3.25 per cent., while the maximum expansion is practically constant over this range.

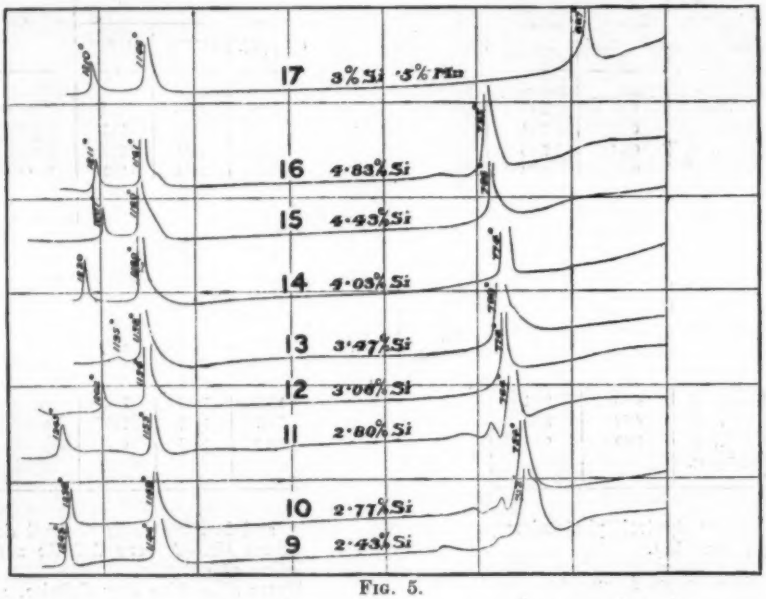


FIG. 5.

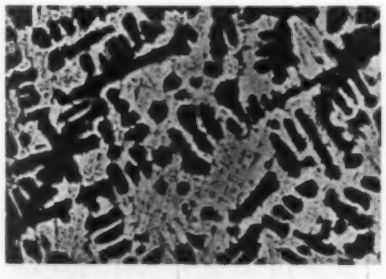


FIG. 8.—BAR 1. Si = 0.02 PER CENT. MAGNIFIED 110 DIAMETERS. RELIEF POLISH.

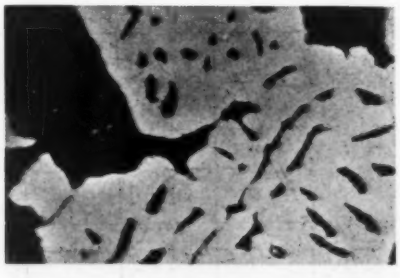


FIG. 9.—BAR 1. MAGNIFIED 1,100 DIAMETERS. RELIEF POLISH.

As will be seen from an examination of the photomicrographs, the increase of silicon beyond 1.5 per cent. produces a fining of the graphite, and a network of fine primary graphite flakes is shown surrounding the pearlite areas. It therefore appears probable that the size, as apart from the amount of the primary graphite, has a distinct connection with its expansion effect; that is, the larger the primary graphite flakes

the greater their expansive influence. The maximum bend at H_3 is also given by about 1.5 per cent. of silicon, but in this case the expansive effect seems to have little connection with the total graphite content,

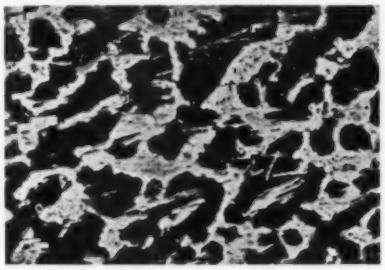


FIG. 10.—BAR 2. SI = 0.23 PER CENT. MAGNIFIED 110 DIAMETERS. RELIEF POLISH.

as the two white bars, Nos. 3 and 4, show almost as great a retardation at H_3.

As will be seen from Table I., the percentage of total carbon is not constant in the series, but

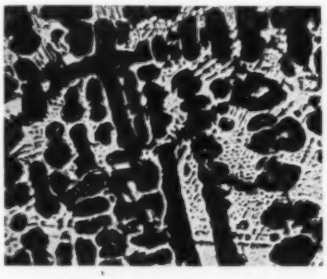


FIG. 11.—BAR 3. SI = 0.66 PER CENT. MAGNIFIED 110 DIAMETERS. RELIEF POLISH.

varies from 2.26 to 2.95 per cent., although melting was always performed in presence of excess of carbon. The lowest percentage of carbon was found in the highest silicon bar, as would be expected, owing to

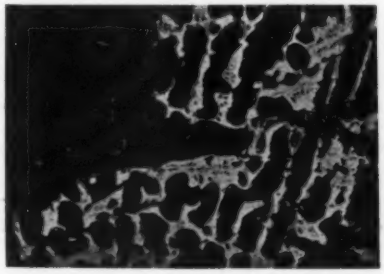


FIG. 12.—BAR 4. SI = 0.97 PER CENT. MAGNIFIED 110 DIAMETERS. PICRIC ETCH. SHOWING CORNER OF GREY SPOT. GREY SPOTS FEW.

the silicon decreasing the solvent power of iron for carbon.

Among the chief points of interest in the results of the series of experiments are:—

(1) *The raising of the lowest Arrest* (H_3) *as the Silicon Increases.*—As the silicon increases from 0 to 5 per cent. the temperature of the lowest arrest rises from 700 degrees C. to 800 degrees C.; thus the effect of the silicon, present as silico-ferrite or silico-cementite,

FIG. 13.—BAR 4. MAGNIFIED 1,100 DIAMETERS.

is to raise the temperature of the point at which the carbide separates out—that is, to increase the range of stability of alpha iron. The temperature with Bar I., containing practically no silicon, is 700 degrees C., this being considerably higher than that given by

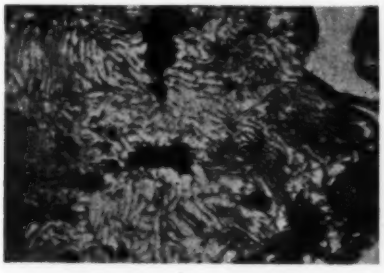


FIG. 14.—BAR 4. MAGNIFIED 1,100 DIAMETERS. GREY SPOT.

Professor Turner in his experiments, in which the temperature for his pure white iron was found to be 665 degrees C. The probable explanation of the difference is, that in Professor Turner's original experiments, the cooling was much more rapid owing to

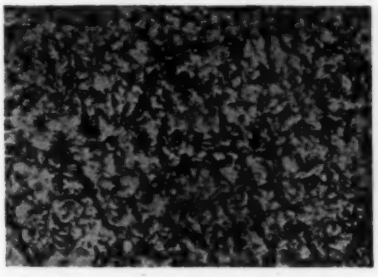


FIG. 15.—BAR 5. SI = 1.19 PER CENT. MAGNIFIED 110 DIAMETERS. PICRIC ETCH.

the much smaller section of test bar employed, and there was a considerable supercooling effect. The author's temperature of 700 degrees C. has been carefully checked, and doubtless gives the point more accurately. It also agrees with Carpenter and

Keeling's results, communicated to the Institute in 1904.

(2) *Slight Raising of the Eutectic Arrest* (H_2) *as the Silicon Increases.*—This temperature rises over the series with considerable regularity from 1,130 degrees C. to 1,160 degrees C.

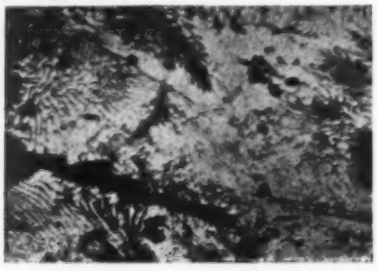


FIG. 16.—BAR 5. MAGNIFIED 1,100 DIAMETERS.

(3) *Lowering of the First Arrest* (H_1) *where the Commencement of Solidification is Indicated.*—The observation in this case is, however, somewhat unsatisfactory. Owing to high temperature and rapid cooling at this point its accurate determination is difficult, and

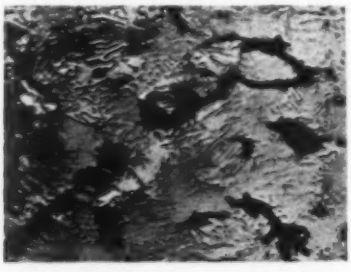


FIG. 17.—BAR 6. SI = 1.50 PER CENT. MAGNIFIED 1,100 DIAMETERS. RELIEF POLISH.

occasionally it is altogether missed. From the direction of the curves the liquidus and the eutectic line would probably meet with about 7 per cent. of silicon.

Mention may here be made of a small but distinct bend out in the extensometer curves of the series,

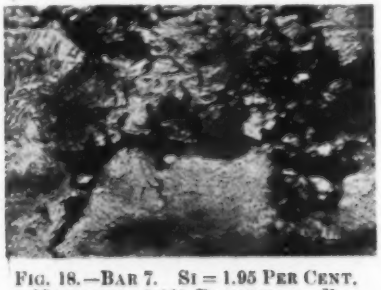


FIG. 18.—BAR 7. SI = 1.95 PER CENT. MAGNIFIED 1,100 DIAMETERS. PICRIC ETCH.

corresponding to a slight temperature arrest in the cooling curves between 800 degrees and 900 degrees C. This heat disturbance is small, and is not always shown up in the cooling curves. The author has not seen this arrest mentioned as having been obtained by other workers. It cannot be due to phosphorus, and it occurs well under the point of the phosphorus arrest as given by Turner. The region of this arrest is shown on some of the inverse rate curves (Figs. 4 and 5). No indications were obtained in the author's curves of the small arrest at about 600 degrees C. referred to by Turner in his Paper.

The time taken for cooling from about 1,350 degrees C. to 550 degrees C. averaged twenty minutes, so that the experimental conditions governing the author's temperature observations would not give results of great accuracy; they can only be regarded as approximately indicating the true equilibrium.

A recent research by Gontermann,* on the "Equi-

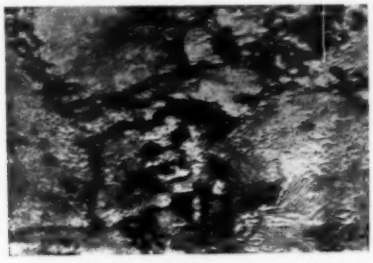


FIG. 19.—BAR 10. SI = 2.77 PER CENT. MAGNIFIED 1,100 DIAMETERS. PICRIC ETCH.

librium of the Iron-Silicon-Carbon Alloys," covers a much wider field, so far as relates to the variation of silicon and carbon, than does the author's series. In this research, however, the system was examined purely on the lines of physical chemistry. The meltings and coolings were conducted in a carbon tube short-circuit furnace, and the amount of metal employed was only 20 grammes, while the cooling occupied about the same length of time as did that of the author's test bars. The materials used for making the alloys were also impure. It might have been expected that the purest metals would have been employed, and it is certain that a large bulk of metal

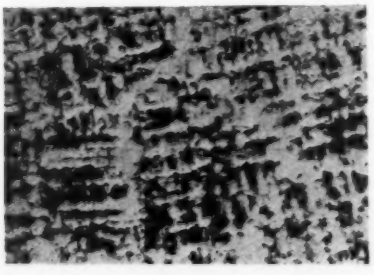


FIG. 20.—BAR 13. SI = 3.47 PER CENT. MAGNIFIED 110 DIAMETERS. RELIEF POLISH.

cooled at a much slower rate would give greater chances of obtaining results representing true equilibrium.

Only a few of the author's results allow of comparison with Gontermann's, but these are in substantial agreement so far as relates to the lower arrests H_2 and H_3 while the arrest H_1 is given at a slightly higher temperature than that recorded with the author's bars.

Stable and Metastable Equilibrium.—It is interesting to note that the small portion of metal which ran up and surrounded the iron pin, during the casting of the test bars, showed in every bar of the series a

* "Zeitschrift für Anorganische Chemie," 1908, vol. lix. pp 373-113.

perfectly white fracture. This slight chilling was always sufficient to produce the metastable condition, even when as in most cases the test bar itself was quite grey, or in the stable condition. It is therefore extremely easy to obtain the metastable state in these pure iron-silicon-carbon alloys. It was also found that the small portions of metal left in the pot after the casting the white bars of the series, and thus

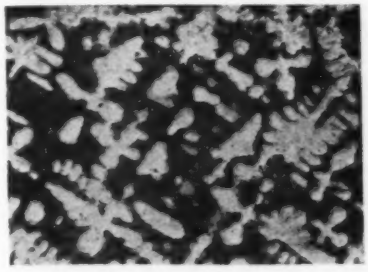


FIG. 21.—BAR 16. Si = 4.83 PER CENT. MAGNIFIED 110 DIAMETERS. RELIEF POLISH.

allowed to cool more slowly than the test bar, gave a grey fracture even when the silicon was as low as 0.03 per cent.

It appears, therefore, that the change from stable to metastable, and *vice versa*, is readily produced by slight variations in the rate of cooling.

State of Carbon in the Series.—It will be noticed from an examination of Table I. that the amount of combined carbon present is in no case lower than 0.64 per cent., and it is at this lowest figure in the bar containing the maximum silicon. In the micrographical study of the bars, in no case was there any

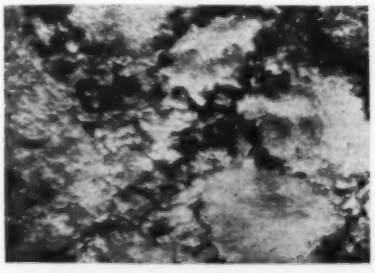


FIG. 22.—BAR 16. MAGNIFIED 1,100 DIAMETERS.

free ferrite found apart from the layers in the pearlite.

The effect of silicon on the pure cast iron is to cause formation of the stable eutectic of graphite and solid solution, but it does not appear to be energetic enough on the stable side to cause the decomposition of any of the carbide required to form a saturated solid solution with the iron. This saturated solid solution changes into pearlite at the recalescence point to form the ground mass of the alloy. It is also noticeable that as the silicon increases the amount of carbide required to form a saturated solid solution decreases. With pure iron the carbon required is 0.9 per cent., while with iron containing 4.83 per cent. silicon the carbon required is only 0.64 per cent.

Effect of Manganese on the Iron-Silicon-Carbon Series.—It will be noted that no actual expansion is recorded in any bar of the author's series at the temperature of the arrest H_3. As Professor Turner, in his experiments with grey hematite iron, obtained a distinct expansion at this point, the author thought the differing results must be due to the 0.5 per cent. manganese contained in the hematite iron, as this was the only substantial difference in composition from the test bars with about 3 per cent. silicon. A test bar was cast containing 3 per cent. silicon and 0.5 per cent. manganese, and the extensometer curve is shown (No. 17, Fig. 3), from which it will be seen that there is a considerable actual expansion corresponding to the arrest point H_3, while the temperature of this arrest is lowered appreciably from 764 degrees C. to 687 degrees C.

The analysis of the manganiferous bar (Table I.) gave only 0.22 per cent combined carbon, while the microstructure consists largely of ferrite and graphite with a little pearlite. A possible explanation of the expansion is that it is caused by the separation of a second quantity of graphite, namely, that from the saturated martensite.

In view of the fact that the sulphur in the bars is never more than the merest trace, it is interesting to

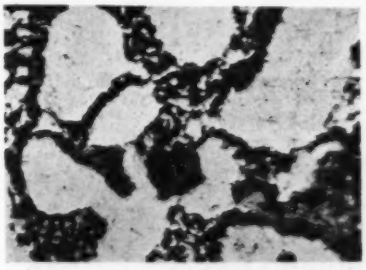


FIG. 23.—BAR 17. MN. = 0.6 PER CENT. Si = 3.0 PER CENT. MAGNIFIED 550 DIAMETERS. DEEPLY ETCHED WITH PICRIC.

record this direct, stable, graphite-forming tendency of the manganese as apart from any indirect effect due to counteracting the influence of sulphur to form the metastable variety.

It appears also that it is only in conjunction with silicon that manganese has this influence, as a bar was cast with 0.5 per cent. of manganese and no silicon, and this gave a white iron with an extensometer curve practically identical with that of Bar 1. The temperature of the H_3 arrest was lowered in this case from 700 degrees C. to 683 degrees C. The effect of manganese in lowering the H_3 point agrees with the known effect in the case of steels. The pronounced action of the small percentage of manganese when added to the silicon cast irons, suggests that it may decide the condition of the silicon in the iron as to whether it is present as silico-ferrite or silico-cementite.

Hardness Tests.—A series of hardness tests were performed with the scleroscope on a polished section of each bar. Considerable variation was found between the outside and centre of bar, but as far as possible an average figure was taken. The results are plotted against silicon content in Fig. 7. The results show the hardening tendency of silicon up to 1 per cent. where the bars are still white. A further increase of silicon produces a grey bar and a noticeably sudden drop in the hardness followed by a gradual rise with the silicon. Hence silicon, whether in solution in the ferrite, or silico-ferrite, as in grey iron, or in solution with the carbide as silico-cementite as in white iron, exerts a hardening influence.

Metallography as an Aid to the Brassfounder.*

By. H. S. Primrose.†

Practically metallography, although not yet raised to the status of an exact art, is gradually coming to be regarded as a valuable aid to the chemist in a well-equipped works making non-ferrous alloys. The microscopical investigation of the structure of alloys is largely superseding the method of judging quality by fracture, and is undoubtedly a more certain guide to the foundryman who wishes to escape the repetition of serious failures due to causes other than change of chemical composition.

The text-books dealing with the subject mostly take up the theoretical side of the constitution of the alloys, many of which have little or no practical or industrial value; and those which do not fall into this category are usually only given as examples of good or selected specimens. Thus metallography, as applied to the needs of the brass- or bronze-founder, still lacks the needed degree of standardisation, and the object of this Paper is to discuss some outstanding cases met with in a large workshop practice, in which the pathological examination of a few failures and defective gunmetal castings has been not only instructive, but of considerable utility in discovering what faults to

FIG. 1.—GUNMETAL FRACTURE, NATURAL SIZE. OBLIQUE ILLUMINATION.

avoid, more particularly when chemical analysis afforded no clue.

The usual standard to which most foundries have to work is governed by rigid specification of the tensile strength and elongation of test-bars from the castings produced, and whilst this method affords a valuable check upon the acceptance of faulty workmanship, failure generally results in throwing the onus on to the metal, but most cases of microscopic examination reveal the fact that structural deficiencies are to blame. The ultimate strength and degree of elongation which a metal possesses depends entirely on the nature of the crystalline arrangement, and this, in turn, depends upon the rate of solidification, as also to a less extent on the rate of cooling after solidification. For each metal or alloy there is a certain size and arrangement of crystal grain which gives maximum strength and durability. If this be exceeded, then there is not sufficient interlocking of the crystals, and thus large cleavage planes are formed, but if the crystal grain be too small, the interlocking may be so minute as to be almost valueless.

As the appearance of a fracture depends largely on the way it is made, its practical value is very limited. If the structure is macroscopic and visible to the naked eye, it usually indicates a too coarsely crystalline structure, or that the specimen has been broken hot.

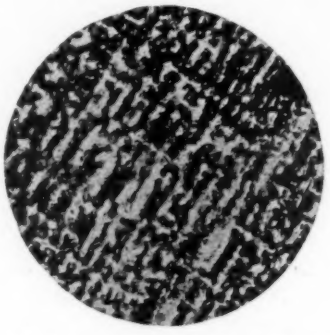
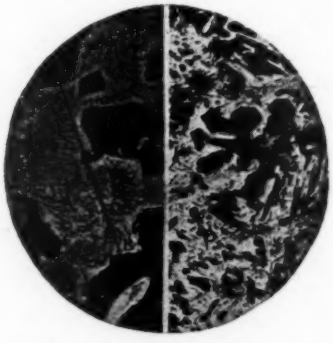


FIG. 2.—GUNMETAL TEST-BAR. MAGNIFIED 60 DIAMETERS.

as is shown in Fig. 1, which represents the holocrystalline structure of a gate of a gunmetal casting, reproduced natural size. When the structure is of fine grain a hand-magnifier may be used, but this reveals nothing of the real or internal structure, for investigating which a microscope must be employed. To avoid the difficulty of focussing even the smoothest parts of the fracture, it is necessary to prepare a plane surface of the metal, and this is done by polishing. Care must, of course, be taken to ensure that the polished surface is kept perfectly level, and "hog-backing" especially should be avoided. File-marks and scratches are removed by application of successively finer emery-papers, but most copper alloys are



MAGNIFIED 240 DIAMS. MAGNIFIED 90 DIAMS.
FIG. 3.—GUNMETAL IN VENT.

so excessively soft that even the finest "000" French emery-paper and the most delicate touch will leave markings which will obscure the structure. The excessive precautions recommended for the final polishing of specimens intended for research work are not

* Read before the Institute of Metals, September, 1910.
† Metallurgist to Messrs. G. & J. Weir, Limited, Cathcart.

always necessary for workshop practice, or as a foundry check. A quite satisfactory final polish can be imparted by the use of a "Selvyt" cloth, stretched upon a polishing disc, moistened with water carrying a small amount of diamantine polishing powder in suspension. The development of the structure is variously accomplished, but the structure is most usually revealed by etching with alcoholic solution of ferric chloride, copper ammonium chloride, etc., and recently heat or oxidation tinting has been coming

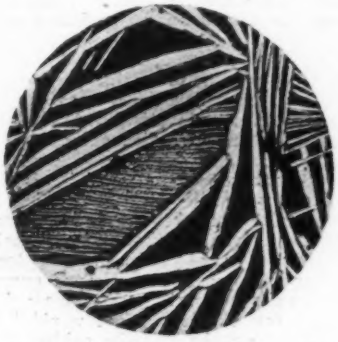


FIG. 4.—10 PER CENT. PHOSPHOR-TIN. MAGNIFIED 60 DIAMETERS.

into vogue. This treatment attacks the various constituents at different rates, and the process must be stopped immediately the mirror brightness of the surface has been destroyed. This often distinctly shows the orientation of the crystals to the naked eye, but when this is not the case a low magnification of 20 or 30 diameters, using oblique illumination, will almost surely do so. The most definite results are obtained by vertical illumination, which is got by a small reflector placed in the tube of the microscope, which, for ordinary work, may be of quite cheap construction, as the magnifications usually employed are low. If photographic records are desired to be kept, or when special investigation is required, it is advisable to

FIG. 5.—10 PER CENT. PHOSPHOR-COPPER. MAGNIFIED 90 DIAMETERS.

employ a more scientific instrument, such as the Rosenhain metallurgical microscope.

The photo-micrographs of gunmetal specimens reproduced are taken from test-bars which were attached to actual castings, and subjected to tension to determine tensile strength and elongation. The composition of the specimens is that of the usual Admiralty gunmetal, viz.—88 per cent. copper, 10 per cent. tin, and 2 per cent. zinc. The castings were made in dry-sand moulds, and as nearly as possible all under the same conditions of cooling.

With gunmetal castings the temperature of pouring has a great influence on the strength of the finished castings. The chief cause for the differences which exist in the quality of the metal is the different rates of cooling and freezing. In the case of the pouring being at a high temperature, just before freezing commences, the sand of the mould becomes highly heated, and so the freezing of the metal is slower than when the metal is not so hot at first, and hence the crystals have time to grow and form a good strong interlocking structure. This is well shown in Fig. 2, which is the photo-micrograph of a test-bar from a casting poured at 1,100 degrees C. and slowly cooled. A similar bar cast at a much lower temperature (950 degrees C.) was cooled much more quickly, and in this instance not only were the crystals prevented from growing, but the constituents of the metal remained practically in a state of solid solution with no well-defined structure, which is unresolved by higher magnification.

As the two casts are of practically the same composition, it follows that the variation in the temperature of casting, and hence the consequent rate of cooling, must have a very distinct effect in the structure or crystalline formation of the metal. In castings that have to stand the test of a high-water pressure the interlaced type of structure is important,

FIG. 6.—BRONZE (CAST). MAGNIFIED 30 DIAMETERS.

so that the temperature of pouring such castings has to be carefully watched. If it is too low when run, the resulting casting will be porous and weak, and will not stand even a moderate pressure of, say 80 to 100 lbs. per square inch, instead of the necessary pressure of 700 lbs. and upwards. The reason for this is obvious from a consideration of the microstructure, as the interstices of the light-coloured copper-rich ground mass (Fig. 2) have been filled in with small land-locked seas of eutectic, and thus soundness results; but with the quick uniform contraction of the solid solution, intercrystalline pores develop, and show as microscopic holes throughout the poor metal. Following on this, it would appear that to get the same quality in all castings, the metal for large and thick castings should not be so highly heated when cast as that which is used for much thinner work. Thus the casting temperature of gunmetal is not a constant, but must necessarily vary with the weight of the casting, as well as its internal and external form, and the number or branches, arms, and projecting parts on the casting. Now if the founder is careful, and bears this fact in mind, many difficulties can be overcome by arranging his moulds of dissimilar castings, so that those of a light nature are cast first with hot metal. It is evident that by using a ladle a great variety of casting tem-

peratures can be got, and occasional pauses may be made between some of the moulds if the temperature is too high for the nature of the work.

Excessively rapid cooling has the effect of rendering gunmetal very brittle, and almost steel-like in appearance and hardness. A sample quenched from just below solidification-point evinced a very marked change in structure, as shown in Fig. 3, and this required a high magnification (240 diameters) to show the copper separated in almost pure crystallites, surrounded by a ground mass of eutectic which is of the hard brittle nature.

The existence of blow-holes in gunmetal weakens the castings to a very considerable extent. The presence of the blow-holes may be due either to slight dampness in the mould when the metal is cast into it, or the gases which form these holes may be actually dissolved in the metal when it is cast. They are often a great source of trouble to the founder, casting after casting having to be scraped on account of such holes, which usually do not show until the casting comes to be machined. They are often quite small and unequally scattered through the field, and it can easily be understood how the tensile strength of the metal is reduced on account of these holes, even although the

FIG. 7.—GUNMETAL TEST BAR.
MAGNIFIED 30 DIAMETERS.

composition is perfectly correct and the metal has been properly melted. A microscopical examination is the surest way of ascertaining the cause of blow-holes. If these are clean and confined to the outer portion of the castings, they are certain to be due to the steam formed within the mould, in which case a simple remelting brings the metal right.

More often the pin-holes in castings appear dirty under the microscope, and on polishing, some brittle material is rubbed out, causing serious scratching of the surface. This is due to segregations of included oxides either of tin or copper, which the small percentage of zinc has not been able to remove. Under this condition remelting is of no avail unless with the aid of some deoxidising agent such as phosphor-tin or phosphor-copper. This need only be added in very small proportions, and which of these is employed will depend on whether the copper or tin is deficient. Their action is due to the phosphide attacking the dissolved oxides, reducing them to metal, and the phosphorus escaping as pentoxide. Figs. 4 and 5, show interesting photo-micrographs of 10-per-cent. phosphor-tin and phosphor-copper, illustrating the structures of the two phosphides and the accompanying eutectic alloy.

In the case of a test-bar which only withstood an ultimate stress of 8.6 tons per square inch, microscopical examination evinced several patches of very indefinite structure fitted with cavities in which oxide inclusions remained. This metal, on remelting with about 0.5 per cent. of the phosphor-copper, gave a casting which stood over 16 tons per square inch, and showed 24 per cent. elongation on a 2-in. test-bar. This small quantity of phosphorus was evidently not only sufficient to remove the intermixed oxides, but also to leave a trace of phosphorus in the metal.

It is not often that gunmetal is cast from large furnaces or ladles, but when this is done in large workshop practice special precautions must be taken to ensure the uniformity of the metal from beginning to end of the cast. Segregation does not so readily take place, but with a great weight of metal in the ladle some scum and dirt is apt to be intermixed; the removal of this is somewhat troublesome, even with stirring and the addition of deoxidisers, unless a billet of green-wood is used to agitate the metal. The stirring is sometimes done by a so-called "secret process," which consists in stirring the metal with an iron rod to the end of which an ordinary potato is affixed.

The heat-treatment of gunmetal is a subject which as yet has not been fully investigated, but the results got by M. Guillet and others on the heat-treatment of the copper-tin alloys show that with the useful bronzes profound changes are effected by varying temperatures of annealing and quenching. Now if gunmetal were subjected to a similar treatment, it is more than possible that equally remarkable changes would be got, and it is proposed to make this the subject of a future Paper.

The constitution of the binary alloys of copper with tin and also with zinc has been very thoroughly worked out, but there is still scope for useful research on the ternary alloys, especially in the region rich in copper. When one considers the large number of commercial alloys of this composition, it is surprising that no systematic investigation has been made in regard to the strength and durability of what Professor Thurston calls the "kalchoids." The addition of zinc to ordinary bronze not only improves the colour, but makes the alloy cast much better. Without materially altering the structure, the zinc prevents the formation of a certain small amount of eutectic, and also acts as a deoxidising agent for any trace of copper or tin oxide dissolved in the metal.

Whilst the pyrometer is of great service in determining the temperature of the metal before pouring, it is not practicable to take the rate of cooling of each casting. Hence it often occurs that perfectly sound metal gives test-bars which fall just short of the required strength, and the reason for this is another point easily explained by the microscope. The microscope, in one case, showed a remarkable instance of the copper crystals having grown too rapidly in certain directions, and thus the required amount of intertwining had not been effected, with the result that the tensile strength was somewhat low. Another case of rather fine-grained structure, almost devoid of interlocking, which possessed low tensile strength and elongation, was also due to incorrect cooling of the metal. It is likely that a suitable annealing would have promoted diffusion and brought the strength of these two castings up to a very much higher standard.

In the examination of gunmetal test-pieces under the microscope, the comparison of the various structures shows very clearly the difference between the good and bad pieces. Whenever the structure is of a good interlocking crystalline type, as shown in Fig. 2, the strength of the metal is always good, possessing a tensile strength of 15 tons per square inch and upwards, with an elongation of 20 to 25 per cent. on 2 in. In other cases the metal is weakened either by the presence of gas in the form of blow-holes, or else the casting is devoid of the good crystalline arrangement which gives the metal its strength.

This comparison very quickly enables the necessary

experience to be acquired for determining the cause of the troublesome defects should such occur, and this is more than half the battle in the direction of putting things right again. Whilst there is still some controversy in regard to the interpretation of the results of the metallographic examination of certain of the bronze alloys, there need be little fear of dubiety in investigating any of the useful alloys from the pathological standpoint. Care, of course, should always be taken to ensure the proper sampling of the test-piece, avoiding any portion which has been subjected to undue stresses; but, on the other hand, the structure right at any point of failure may be examined with benefit, since it is through profiting by faults that ultimate success is achieved.

The annexed table gives full particulars of the composition and physical properties of the specimens illustrated by the photo-micrographs.

Fig. No.	Material.	Analysis.				Tensile strength. Tons per sq. in.	Elongation per cent. on 2 inches.	Remarks.	Microstructure.
		Copper, per cent.	Tin. per cent.	Zinc, per cent.	Phosphorus, per cent.				
1	Gunmetal, gate	88.0	10.0	2.0	—	—	—	Broken hot ...	Highly crystalline fracture.
2	Gunmetal, bar	88.0	10.0	2.0	—	16.4	25.0	Good standard metal	Good crystalline structure.
3	,, (chilled)	88.0	10.0	2.0	—	—	—	Sample from vent	Brittle eutectic structure.
4	Phosphor-tin .	—	—	—	10.25	—	—	—	Tin, with phosphide of tin crystals and eutectic.
5	Phosphor-copper	—	—	—	9.78	—	—	—	Phosphide of copper crystals in copper phosphide eutectic.
6	Bronze (cast) .	88.0	12.0	—	—	12.0	5.0	Hard coinage metal	Good structure, but pitted.
7	Gunmetal, bar	87.8	9.0	2.3	—	16.0	19.0	Good casting metal	Very good structure.

Collapsing Core Bar for Small Pipe Bends.

By J. McKinlay.

The following are instructions for operating a collapsible core-bar for small pipe bends, as illustratetd in the accompanying sketches.

In making the box, commence by putting one-half of the pattern on a plain board, and ram up the drag. Now tumble over the drag, making the joint level with the pattern, and put on the top half of the pattern. Then ram up the top part, putting two screws in to lift the top pattern. Take off the top part, and draw out the patterns; then proceed to make the core.

The core-box is in two halves, as shown in Fig. 2. To make the core, fill in sand to the joint, and bed in the core-bar, which is now fitted together, and ram firm. Now ram up the top part, and put a string vent along the top of the core-bar; then close both parts together, and pull out the vent string. Take off the top half of the core-box, and extract the core from the drag half. The core while being dried and finished should be rested on two supports at G, Fig. 2,

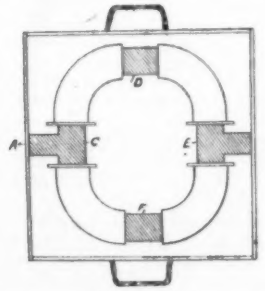


FIG. 1.—PLAN OF PATTERN IN MOULDING BOX.

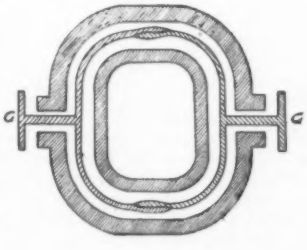


FIG. 2.—PLAN OF CORE-BOX PARTLY RAMMED UP, SHOWING CORE-BAR WITH JOINTS.

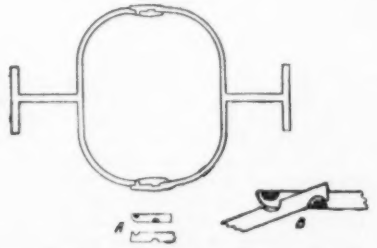


FIG. 3.—CORE BAR FITTED TOGETHER.

FIG. 4.—JOINTS OF CORE-BAR.

Now tumble over the drag, making the joint level with the pattern, and put on the top half of the pattern. Then ram up the top part, putting two screws in to lift the top pattern. Take off the top part, and draw out the patterns; then proceed to make the core.

The core-box is in two halves, as shown in Fig. 2. To make the core, fill in sand to the joint, and bed in the core-bar, which is now fitted together, and ram the weight of the core keeping the joints of the core-bar firm. Fig. 4 shows the joints, and Fig. 3 the coupled core-bar.

The core cuts the mould at the four bearings C, D, E, F, leaving the mould for four castings. To take the core-bar from the castings, bend at the joint of the core-bar, as shown in Fig. 5, making the core-bar into two, and castings taken off each half.

The Working of a Cupola.

By J. Forster.

Regarding the article by S. H. Chase in your June issue, the writer is not quite in agreement with some of the facts stated. The following notes are the result of daily experience in cupola working:—

The Melting Zone.—In reference to the melting zone I have found that the metal starts to melt on the bed coke, which should not exceed 2 ft. above the tuyeres, and if they are double tuyeres—that is, one above the other—should not exceed 18 in. The melting zone entirely depnds upon the quantity melted. Quantities varying from 5 to 15 tons have a melting zone from 2 ft. to 2 ft. 6 in., and where there is as much as 50 or 60 tons per day, the zone reaches 6 ft. above the tuyeres and sometimes higher, according to the condition of the metal and height of the charging door.

Repairing the Cupola.—I do not approve of filling up holes with fireclay or ganister, for when either is used by itself it melts or runs down to the bottom of the furnace; and likewise when teeming the bed coke from the charge door it sticks into the clay or knocks it to the bottom, making it useless. So it is policy to use firebricks with either of the above. When repairing, the first row of bricks should protrude an inch over the tuyeres, as shown in Fig. 1, sloping back towards the charge hole; this keeps the tuyeres clean and bright, preventing arching or hanging, and gives quick melting results.

Making the Tap-hole.—The writer's method differs from that described by S. H. Chase, which is that of a sand tap-hole, which is often troublesome and never reliable. For instance, after having tapped a ton or so it may be necessary to stop the blast through moulds not being ready, or for other causes; and when on again commencing to tap the metal is dull or thick, which makes it difficult to run through the hole. The rod or tapping bar is then used, breaking the skin of the sand, which rushes away, making a very large hole and one which is sometimes difficult to stop, apart from being dangerous. A more secure tap-hole is made of fireclay or ganister, and will last from five to eight days if made and used properly—that is, with blows not more than 20 tons per day. First lay a long piece of round wood, about 1 in. diameter and 18 in. long, on some fireclay level by the runner, with a fall towards the ladle; then ram fireclay or ganister made like stiff mortar, into the hole almost flush with the cupola plate. Then cut out with a knife or piece of wood the shape of the tap-hole, which should be funnel-shaped, leaving the stick in all the while; then go into the furnace and smooth the clay the shape of the brick lining. On coming to where the runner is, draw the long piece of wood, leaving the tap-hole 1 in. long tapered to 6 in. like a funnel. Dry it by placing a hot rod two or three times into the hole.

The Making of a Tap-hole for the Rapid Cupola with Receiver or Reservoir.—This tap-hole should be made in a box according to the dimensions of the receiver door, where the tap-hole is used, taking care to leave a space about 2 in. on both sides and the same on top of the plug with the tap-hole in. First take the box, place it on the bench on a dry, level place; place a piece of tube or inch rod upright at one end where the tap-hole should be, and ram some fireclay round it, making a layer of clay in the box about an inch. Then place nails or pieces of iron so as not to interfere with the hole, then ram fireclay on top and so on till the box is filled up level, taking care not to make the clay too wet or it will be difficult to handle. Cut the hole the shape required, and draw the tube or rod; place it on the plate and put into a stove to dry. The box is generally about 12 in. long, 10 in. wide and 5 in. deep. Fig. 2 shows the tap-hole and door in the receiver cupola.

The Lighting-up of the Cupola.—The following method is speedy and saves the time of waiting to begin to charge. First place long pieces of firewood to reach from the bottom of the furnace to the tuyeres at the tap-hole and opposite the drawing-hole door; then place the remaining wood from the tap-hole to the top of the door, thus forming a sort of arch, taking care not to leave cavities so as to let the coke come through. This enables the cupola to be charged right up to the charging hole with the required charges the day before lighting up, or even the week before it is required to cast; and bed coke can be saved by this method. It is possible to make the door up and blow away as soon as the fire is seen at one or any tuyere, the time being from half an hour to one hour.

Tuyeres.—Some tuyeres are long, round pipes with the blast entrance about 6 in. diameter and the exit into the furnace about 2 in. diameter; this, in the writer's opinion, forces the blast too much, and is often the cause of dull metal, and generally causes arching or hanging of the cupola. The best results are

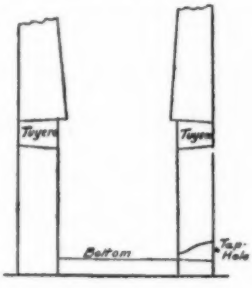


Fig. 1.—Cupola with Lining Protruding over the Tuyere.

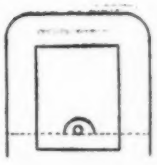


Fig. 2.—Receiver Door, with Plug in Centre and Top Hole.

obtained by the writer with tuyeres made 4 in. square or round at the entrance and about 5 in. at the exit into the furnace; this makes a light blast and gives hot metal.

Charging.—The important points in charging should not be overlooked, such as weighing the metals and coke accurately and keeping the charges level. If this be done, and the coke is level over the charge, when the charge comes down to the melting zone the blast gets through the coke, making the metal melt equally all over the furnace. Care should be taken to break the limestone small and spread it over the charge; this enables it to act quickly and flux the metal properly. One can often find lumps of limestone in the rubbish, or what has been drawn from the furnace; this is through too much being used or being too large when put into the furnace. The quantity required is about 14 lbs. of good blue limestone to one ton of metal. It may be noted that in many places coke is placed on the top of the last charge; that coke is practically wasted, but not so with limestone. There should be twice as much limestone used for the last charge, and if this limestone is small it

will give grand results in raking out, and also cleaning the furnace, making it better to repair. As to the quantity of coke per ton, the writer does not think 2 cwts. of coke sufficient for one ton of metal, including the bed coke, unless the amount of metal exceeds 25 tons per blow. To get hot metal without using extra coke an advantage can be gained by using water, not wetting the coke too much, and only the last half of the bed coke.

A few important points for the cupola attendant to observe are as follows:—First, never make the tap-hole more than an inch long, and the clay for stopping up must neither be too soft or too hard, for there is a tendency for the former to go right into the furnace and make it difficult to open, while the latter becomes too hard to open without trouble. When blowing with a damp tap-hole, stop off the tuyere nearest to it; if the tuyere has no valves insert an inch brick inside against the tuyere hole, preventing the blast from entering. This heats that side of the cupola in particular, and it is also a good way of cleaning the tuyeres. In case of hard holes through having the blast off for a long time, after trying the hole, if not successful keep the blast on and then open the slag hole and let some metal run through it; in the meantime try the tap-hole to open. It is possible to get a furnace all right after standing two hours with melted metal with the above method. When making a bottom in the stationary cupola, make of yellow loam, ramming it well down; then sprinkle water over it, which forms a good smooth surface.

The Edgwick Works Foundry, Coventry.

Visit by Birmingham Foundrymen.

An interesting visit by the Birminigham Branch of the British Foundrymen's Association took place on Monday, October 10, when a party of about 25 members inspected the foundry and other departments of that part of the works of Alfred Herbert, Limited, of Coventry, known as the Edgwick Works. These works were briefly described and illustrated in our issue of October, 1909, but the following fuller particulars may be of interest.

The firm was established in 1888 for the manufacture of machine tools. At the present time it employs about 1,550 men, and has a world-wide fame for the production of machine tools. The head works, which employ about eleven hundred men, are situated in The Butts, near the railway station, but the foundry is at Edgwick. Here the firm has a branch works entirely self-contained and devoted chiefly to the manufacture of rolling machines, though in the foundry castings for many other purposes are produced. The yard and buildings into which raw materials, whether for engineering purposes or for foundry use, are received, are close together and handy for the shops in which the materials have to be used. In the foundry department, for instance, the timber store immediately adjoins the pattern shop, while the moulding shop and the foundries are close at hand.

One feature of the methods adopted at the Edgwick Foundry is that no deep boxes are used, all the boxes being built up of standardised sections, with uniform pins. The pattern stores are on two floors. On the upper floor each section is divided into bays which are indicated by tablets conspicuously lettered, so as to be located from either end of the building. The shelves, which run at right angles to the central passage, are numbered and a card inside is kept giving the number of the pattern, bay, and the shelf. This applies to all patterns of a small or moderate size, while the larger patterns, which can be more easily identified and located, are stored on the ground floor.

In the heavy foundry are made all the larger castings, such as lathe beds, milling machine bodies, and the frames for the universal grinding machines. All the heavier castings are made in dry sand moulds. The smaller castings are made in the light foundry, where five Tabor moulding machines with an equipment of over 1,200 pattern plates are installed. The oldest machine has been running five years, and has not cost £2 in repairs. Machine moulding is applied in every possible case, everything which will come into a 16-in. by 14-in. box being put on machines. Over 2,000 boxes are in use. In this foundry was seen the firm's special method of casting the smaller turrets and cast-iron bushes in iron moulds, producing a fine close-grained metal entirely free from dirt and blow-holes. It was explained that the strain upon a machine-tool turret is so great that an absolutely perfect casting is indispensable, and that the method of casting in an iron mould with sand tops has been found the only possible one to secure this desideratum. Some of these chilled castings were poured, and others turned out in the presence of the visitors, who, as expert foundrymen, expressed great admiration of the results of the process.

In the bronze foundry, the bronze, brass, and aluminium and other special metal castings are made. This foundry possesses one Tabor moulding machine. Among the castings which were being made were metal bodies for motor car carburreters, 1,100 sets of which, embracing each a number of separate castings —sometimes a dozen—are turned out in a month.

The laboratory adjoins the light foundry. It is in two large storeys, and is excellently equipped. The fume chamber in the chemical department on the upper floor is efficiently ventilated by means of a draft induced by a fan working in a shop some distance away, and, therefore, not exposed to corrosion. All the metal mixtures used for the different classes of castings are carefully tested every day. The samples are tested for contraction on cooling, and for depth of chill on the ends of test pieces, which are cast between iron ends exactly 12 in. apart and are also given a shearing test. A large testing machine by W. & T. Avery, testing up to 1,840 lbs., is used for special tests. The mixtures for melting are regulated chiefly by the mechanical tests, though the results of these tests are constantly compared with the analysis of physical qualities made by the chemist upstairs. The shrinkage is tested by a special micrometer up to an unusually small fraction of an inch. In five years over 5,000 test bars have been dealt with and the records plotted out in curves. The treatment of iron castings with 6 to 1 dilute sulphuric acid is adopted to remove the outer skin in order to facilitate machining. A special method of annealing is practised where special tools of an expensive character have to be employed on castings.

The pattern shop is equipped with an up-to-date assortment of wood-working tools and special ventilating appliances, and the building, like all the other departments, is light and airy.

In the sand-mixing shed, the visitors were particularly interested in the firm's sand mixing machine. This machine was designed after unsuccessful efforts to obtain from other machines sand suitably mixed for the firm's foundry purposes.

After leaving the foundry department, the visitors passed through the machine shops, where they admired the thoroughness of the organisation and the extremely convenient manner in which the shops are laid out.

The Heat Treatment of Brass: Experiments on 70 : 30 Alloy.*

By G. D. Bengough and G. F. Hudson.

The authors have studied the general effect of heat treatment on the mechanical properties of 70 : 30 brass, and have paid special attention to the question of burning. Bars and wires made by different manufacturers were used in order to ascertain to what extent variations in character of the alloy and size of section influenced the results. The mechanical tests of the bars and wires after they had been annealed for half an hour show, in agreement with the results of previous workers, that the best annealing temperature is between 600 degrees and 700 degrees C. For this time of annealing a temperature within a few degrees of the melting point does not seriously injure 70 : 30 brass which is free from tin and lead, but, if maintained for a sufficiently long time, a temperature nearly 100 degrees C. lower will burn the brass. The presence of small quantities of impurities, as previously recorded by Charpy, has an important effect in increasing the tendency to burn. The atmosphere of the annealing furnace, whether oxidising or reducing, does not appear from the authors' experiments to affect in any well-marked manner the properties of the brass. The loss of zinc by volatilisation during the annealing process is inconsiderable except at high temperatures, and even then appears to be mainly a surface effect. Besides the ordinary mechanical tests of bars and wires after annealing, tests were also made on the mechanical properties of brass wire at high temperatures. It was found that the maximum stress decreases continuously as the temperature rises. The elongation and contraction of area fall off to a very low value at temperatures between 300 degrees C. and 400 degrees C., after which a recovery of ductility occurs, and is practically maintained up to 590 degrees C., which was the highest temperature used in this series of tests. The Paper includes a number of photo-micrographs illustrating the different stages in the growth of the crystals as the result of annealing.

Cupola Slags.

British Foundrymen's Association: Sheffield Branch.

At the opening meeting of the Sheffield Branch of the British Foundrymen's Association, held on October 25, Mr. Percy Longmuir, B.Met., presiding, Mr. T. Swinden read a Paper on "Cupola Slags," an abstract of which is as follows:—

Already in blast furnace, Siemens, and electric furnace and numerous non-ferrous processes it is acknowledged that the condition and composition of the slag is largely indicative of how the process is progressing. An ordinary cupola slag contains, say, 7 or 8 per cent. oxide of iron, equivalent to 6 per cent. metallic iron, and even in average working one may easily reach double this figure. Surely then there is room for study as to how this comes to pass, and how this loss can be limited.

It is necessary first to understand what is meant by acid and basic materials; how one neutralises and combines with the other; then the relative strengths of these oxides occurring in slags and how they are balanced in such a slag as is produced in cupola practice. Tables are given, for use in working out silicate or acidity grades with very little trouble. Then as to fluidity (which is the real property in the slag, which the cupola tenter wants), data is given for single, double, and triple silicates as to fusibility. The theoretical side is well worth attention, even on such a practical problem as this. Real progress was never made by what the American calls "workshop kinks"; but rather on a broad comprehensive study of the principles involved.

Two main axioms for the practical man are:—

(1) There is always a tendency for acid material to search out and combine with basic, and *vice versâ*.

(2) For every combination of a series of acid and basic oxides, there is a certain ratio of one to the other which will produce the most fusible slag.

Practical experiments have been made on the influence of quantities of lime on economic working of cupola. It is shown conclusively that excessive use of lime to "thin" the slag may facilitate working, but means loss of iron in the form of oxide in the slag. The actual lime content of the slag may be quite erratic, but the thin slag is always higher in iron oxide. The explanation of this is that as the slag becomes more basic (with additions of lime), the ratio of iron oxide to lime necessary to preserve fluidity is considerably increased. This is known to be the case with manganese-lime-silicates, and is due to the greater fluidity of iron or manganous oxide silicates than lime silicates. The best proportion of lime is then the least quantity consistent with the clean working of the cupola. In good practice it is about 30 lbs. to the ton of iron melted.

Interesting data on the influence of the several oxides on the colour of the slag is forthcoming. For example, the "thin" cupola slags are always very black, and this is due to the high content of iron oxide. The different oxides have a different influence on the colour and appearance of the slag.

The Paper concludes with typical analyses of refractory materials, etc., likely to be of use in studying the formation of slag.

Welding Cast Iron.

A process for welding cast iron which has met with considerable approval in various quarters, is that of Messrs. Wassermann & Company, of 13, Fenchurch Buildings, London, E.C. This process employs a chemical compound known as "Castolin," by the use of which broken castings can be welded, the broken part reinforced, weak sections increased in thickness, and blow-holes, etc., be filled.

For welding with this compound, a thin layer of it has to be applied to the broken surfaces, after having been thoroughly cleaned. The broken pieces are then tightly clamped together and made red-hot, when the Castolin welds them. Castolot, a special granulated brass spelter, is employed to braze them and fill up all small pores, this being applied prior to a second heating.

Castolin being always ready for use, the welding of small castings requires only 20 to 30 minutes, and for heavy castings a few hours only. No special plant or implements are required; an ordinary smith's hearth or a portable forge will deal with castings up to 7 cwts. Large hearths are necessary for heavy castings.

It is claimed that any kind of cast iron can be welded by Castolin, without being depreciated, while it is also possible to weld and braze cast iron on wrought iron, steel and on any other metal, such as bronze, copper, silver, etc. Castolin joints, also, can be easily machined. The auto-chemical effect of this compound consists in welding and brazing the metal simultaneously, therefore the points resist

* Abstract of Paper read before the Institute of Metals, 1910.

heat, acids, water, oil and steam. Cast iron welded and brazed by Castolin, has given tensile breaking strains of more than 10½ tons per square inch.

For the autogenous welding of cast iron it is necessary to make an application of Castolin on the surfaces and heat and cool slowly the casting. The autogenous welding becomes then more easy and sure.

It may be mentioned that Mr. J. Glass, 121, Rusholme Road, Manchester, is the North representative in this country for the Castolin process.

Moulding a Boiler Cleaner.

By J. McKinlay.

The following is a description of and instructions for moulding a boiler cleaner, which is tested to stand a pressure of 500 lbs. to the square inch.

In the making of this job the core should be made first. Begin by putting the core bar (see illustration) into the hole in the stool, Fig. 1. Then place on the stool the two quarters, which form the bottom half, and bolt them together; at the same time tighten up the core bar, which has a screw, as shown, for receiving a nut. Fill in sand to the first hole in the core bar; through this hole is put a pin, and then a small loose core bar, which is wedged on top by another pin, as shown in Fig. 3. Place on the other two core bars in the same way, and ram to the level of the bottom half with sand.

Moulding the Box.

The box consists of three parts, the pattern being in two halves with loose branches and flanges. Fig. 5 shows the bottom half or drag after it has been rammed up and turned over, and also the mid-part and top half of the pattern, the box being rammed up and the joint or parting made. The top-part is shown with flow-gates or risers rammed up, the pouring-gates being shown in Fig. 6. The

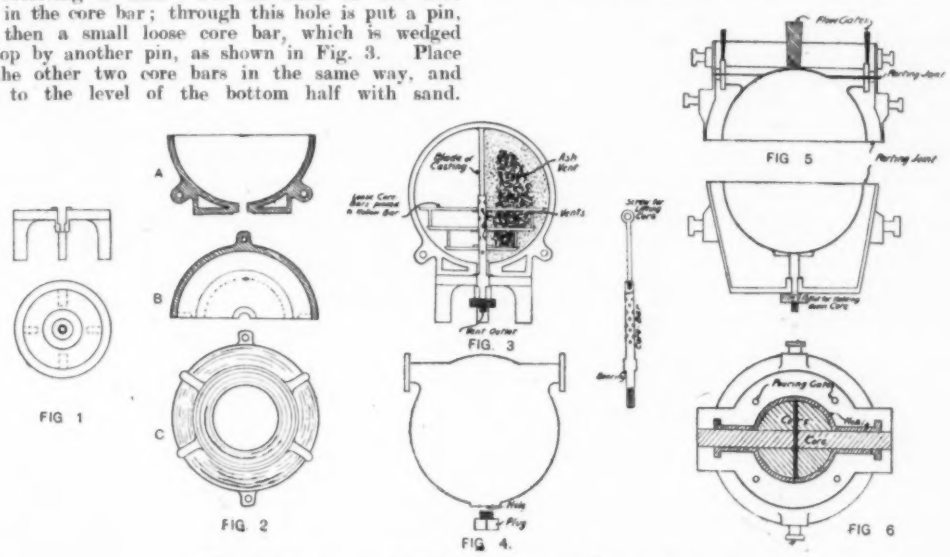


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

ELEVATIONAL AND SECTIONAL VIEWS OF BOILER CLEANER.

Take the trowel and cut down to the vent holes in the hollow core bar, taking care to see that the holes are properly clean; then give the core a prick with a vent wire, and fill with ashes. Put on the cope or top-part, C, Fig. 2, with blade, which is secured by pins passing through from the outside of the cope. Ram up with sand to top of the cope on each side of the blade, then cut down to the ash bed, so as to give a clear vent, put in more ashes, and cover with sand. Finish the sphere with a trowel, then take off the cope, and prick into the ash vent to keep it from scabbing. Finish with the trowel, and draw out the blade; take out the bolts from bottom quarters, and draw them aside.

To lift the core, put the screw down the division and screw up, as shown in the illustration. While the core is hanging from the crane finish the surface with the trowel; then black-wash, and put into the stove to be dried. The core stands on a stool similar to that of the core box. The sand used for this job is the ordinary jobbing moulder's green-sand facing sand, to the same proportion of rock-sand, mixed together and put through a quarter riddle.

method of drawing the patterns from the mould is as follows:—Take off the top part, and draw the loose branches and flanges; then close on the top part, and fix to the mid-part. Take off the mid-part and top part together, also lifting the top half of the pattern. Turn over the box, and draw the pattern, then loosen the net, shown in A, Fig. 5, and draw the drag pattern. Finish the mould, and black-wash, then skin dry over a good char fire. The simplicity of the job is in the coring up, the spindle on the bottom half of the pattern forming the bearing for the main core. After the core has been lowered into the mould, put on the nut, and screw it up tightly against the cross-bar of the box. This is all that holds down the core, no chaplets being required; put on the mid-part now, and lay in the branch core, a hollow being made in the main core allowing it to lie on its bearings. Put on the top part now, and make ready to cast.

The diameter of this casting is 28 in., having 1 in. thickness of metal all over, and the weight 6 cwts. This casting must be poured with clean hot metal, otherwise it will be unable to stand the test.

The Comparative Values of Foundry Annealing Ores.

By F. H. Hurren.

Even in many foundries where iron is bought and mixed to analysis, little or no attention is given to the analysis of the annealing ore. The ore, as purchased, should be dry, of a brick-red colour, and the pieces, or kibbles, sufficiently hard to resist crushing between the finger and thumb. Many of the ores the writer has come in contact with are soft and "clayey," and have a greasy feeling when rubbed between the fingers. These ores take quite ten days to anneal the castings and a much larger percentage of new ore is required in the mixture. In many instances, too, the castings come out of the oven covered with a dark, glassy substance, which no amount of "barrelling" will remove, and each casting has to be separately sand-blasted. Even then, a film of this glassy substance remains on the casting, to the detriment of tools. From an analysis of this film, the writer has found it to consist of a calcium-silicate containing iron-oxide in suspension; the reason for its presence will be shown later.

The ore, as delivered, should contain no more than 3 per cent. of moisture, as no firm wishes to pay up to 57s. per ton for water, when the same commodity can be obtained from the foundry tap at a cost of from twopence to threepence per ton. Of course, in some instances, a high percentage of water is brought about by defective protection while *en route*, but this may be detected by the top layers of ore in the truck being wetter than those underneath.

The chief constituents of annealing ore are ferric-oxide (Fe_2O_3), ferrous-oxide (FeO), silica, and traces of lime, magnesia, alumina, sulphide of iron, and magnetic oxide of iron (Fe_3O_4). In Table I. are given three analyses of typical ores, the figures, for the sake of comparison, being taken on the dried ore:—

TABLE I.

	1.	2.	3.
	Per cent.	Per cent.	Per cent.
Ferrous-oxide	1.23	1.21	1.14
Ferric-oxide	88.80	81.40	83.28
Silica	7.80	11.14	13.72
Lime	Nil.	Nil.	1.45
Sulphur	0.09	0.02	0.03

It will be seen that the ferric-oxide varies between 81 and 89 per cent., the ferrous-oxide averages just over 1 per cent., while the silica varies from 7.8 to 14 per cent. These three ores each gave excellent annealing results, the castings coming out in a clean condition, and requiring very little tumbling to take a good polish.

In Table II. are given four analyses of ores which did not give satisfactory results:—

TABLE II.

	1.	2.	3.	4.
	Per cent.	Per cent.	Per cent.	Per cent.
Ferrous-oxide ..	2.52	0.12	0.06	0.64
Ferric-oxide ...	53.60	50.05	75.73	76.72
Silica	26.60	25.02	15.58	17.20
Lime	6.24	12.16	3.57	1.25
Sulphur	0.57	0.54	0.02	Trace.

The first two show extraordinarily high percentages of silica and lime, and low ferric-oxide. Castings annealed in these ores were so covered with a dark brown, semi-opaque glass, that its removal was almost an impossibility. As previously mentioned, this glass had the composition of a calcium-silicate. In the writer's opinion the excess of silica and lime combines, at the high temperature of the oven, to form a fusible silicate, which runs all over the castings, and on cooling down sets to a hard, brittle film.

Nos. 3 and 4 in Table II. are analyses of ores which gave satisfactory results only on prolonging the time in the ovens to eleven or twelve days. In one oven the temperature was raised to such a pitch, in an endeavour to hasten matters, that the edges of the castings were fused, and particles of ore were permanently embedded in the iron. The cause of these poor results, the writer is sure, was the low percentage of ferric-oxide, making the ore naturally weak without the addition of spent ore.

In Table III. are given six analyses of different brands of ore, the first four giving uniformly unsatisfactory results, due to the low percentage of ferric-oxide and high content of lime and silica. The last two gave excellent results, No. 6 particularly being the best specimen out of about one hundred and fifty samples.

TABLE III.

	1.	2.	3.	4.	5.	6.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Ferrous-oxide	0.20	1.01	0.67	1.04	1.44	0.12
Ferric-oxide	78.57	74.02	76.60	77.30	82.21	95.36
Silica	18.75	17.70	14.21	13.40	11.53	3.50
Lime	1.60	1.28	2.72	4.21	0.35	Nil.
Sulphur ...	0.04	0.06	Trace.	0.02	Trace.	Nil.

The action of annealing on the ore is to reduce the ferric-oxide to ferrous-oxide, this being practically the only change taking place, the other constituents remaining much as they were before. This may be seen from the analyses given in Table IV.

TABLE IV.

	New Ore.	Spent Ore.
Ferrous-oxide	0.64	76.01
Ferric-oxide	81.40	1.80
Silica	15.92	19.50
Lime	1.73	2.30
Sulphur	0.01	Trace.

The chief desiderata in an annealing ore may be summed up as follows:—The composition must consist, in the main, of ferric-oxide. Silica and lime must be present only in small quantities. The ore must not contain more moisture, when delivered, than it could reasonably be expected to pick up on rail. At least 80 per cent. should be ferric-oxide, good brands averaging 85 to 88 per cent. Ferrous-oxide should not exceed 1.5 per cent., otherwise adulteration with spent ore may be suspected. Silica should not exceed 12 per cent., although a

slightly higher content will do no harm, provided lime is present only in traces. This latter should never exceed 1.5 per cent., and the maximum sulphur content allowable is 0.1 per cent.

Analysis should be employed to determine, first, whether an ore is of the right composition; if this is right, the desired annealing properties follow as a matter of course.

Analysis of Ores.

The following is an outline of the methods most suitable for the analysis of annealing ores. These methods have proved very trustworthy, and are quickly carried out:—

Moisture.—Two grammes of the ore as delivered, are weighed into a tared dish, and placed in the air oven at a temperature of 105 degrees C., for three hours. The dish is removed from the oven, allowed to cool in the balance case, and re-weighed. It is then put back in the oven again, cooled, and again re-weighed. This process is repeated until two consecutive weights are the same. The loss in weight is due to moisture.

For the remainder of the analysis it is as well, for purposes of comparison, that the ore be dry. About 10 grammes of the ore are crushed in a mortar, and dried for two hours in the air oven, at 110 degrees C. The sample is then finely ground, and passed through a 90-mesh sieve. The sievings are placed in a clean bottle, and used for the analysis.

Ferrous Oxide.—A solution of potassium bichromate is first made, by carefully weighing 4.383 grammes of crystals, which are then dissolved in about 200 c.c. of hot water. When quite dissolved the solution is cooled, transferred to a litre flask, and made up to the mark with recently boiled, distilled water. Each c.c. of this bichromate solution is equivalent to 0.005 gramme of iron.

For the actual determination, weigh out carefully 0.5 gramme of the sample, into a 250-c.c. conical flask, add about 0.2 gramme of pure sodium-carbonate, and 25 c.c. of concentrated hydrochloric acid. Insert a rubber stopper fitted with a short glass tube, to which is attached a small rubber valve. Boil the contents gently for 15 minutes, remove the stopper, rinse down the sides of the flask with water, and dilute with 80 c.c. of recently boiled water. Cool under the tap, remove a spot of the solution on a glass rod, place it on a white tile, and add a spot of dilute potassium ferro-cyanide solution. If no blue colour is formed, ferrous-oxide is absent. If a blue colouration is obtained, run into the solution, from a burette, the standard bichromate mentioned above. Only a few drops should be added at a time, and the solution periodically tested on the tile with ferro-cyanide solution until no blue colouration is formed. The volume of bichromate added is read off from the burette in c.cs.' This multiplied by 1.2857 gives the percentage of ferrous-oxide.

Ferric-oxide.—0.5 gramme of the sample is weighed into a 500 c.c. conical flask, 25 c.c. of concentrated hydrochloric acid added, and the liquid boiled gently for 15 minutes. The cover and sides of the flask are washed down with water, the solution cooled under the tap, and ammonia added until a small permanent precipitate is formed; 25 c.c. strong sulphurous acid and 50 c.c. water are added, and the solution boiled until it no longer smells of sulphur dioxide. Then add 10 c.c. dilute sulphuric acid, and titrate with standard bichromate, in the manner indicated under ferrous oxide. It is usually safe to run in 50 c.c. bichromate at once, and then a few drops at a time. An average annealing ore requires from 55 to 65 c.c. With a little experience it is not difficult to judge the nearness of the end reaction by the colour of the solution. From the volume of bichromate required is deducted the volume used for the ferrous-oxide determination, and the difference multiplied by 1.4286 gives the percentage ferric oxide.

Silica.—1 gramme is weighed into a 400-c.c. flask, 25 c.c. concentrated hydrochloric acid added, the liquid evaporated on the hot plate to complete dryness, and the residue baked for 20 minutes. The beaker is allowed to cool, 20 c.c. of concentrated hydrochloric acid and 5 c.c. water added, and brought to the boil. The liquid is filtered through an ashless filter paper, all particles removed from the sides of the beaker, and both the beaker and paper washed with hot dilute hydrochloric acid and cold water alternately. When all traces of yellow colour are removed from the paper, it is dried and ignited in a platinum dish. This is allowed to cool in the balance case, and weighed. About 0.5 c.c. hydrofluoric acid is added to the dish, which is then heated, gently at first, and then to a red heat. After cooling, the dish is reweighed. The loss in weight multiplied by 100 gives per cent. silica.

Lime.—1.4 gramme are weighed into a 400-c.c. beaker, 40 c.c. concentrated hydrochloric acid added, the liquid boiled down to about 15 c.c., and 2 c.c. concentrated nitric acid added, after which the evaporation is continued to complete dryness. The residue is taken up in 30 c.c. concentrated hydrochloric acid, boiled, cooled and poured into a 70-c.c. flask. The beaker is washed out two or three times with a few c.c. water, and the washings added to the flask, after which the liquid is made up to the mark with water, and the contents of the flask thoroughly mixed by shaking. Filter off 50 c.c. through a dry paper. This corresponds to 1 gramme. Dilute to about 75 c.c., and add ammonia until faintly alkaline. Filter off the precipate, washing it two or three times in hot water. The filtrate is set on the hot plate to concentrate. The precipitate is re-dissolved in the smallest quantity of hot dilute hydrochloric acid, and the paper and funnel well washed. Boil down the solution to about 5 c.c., and again add ammonia until faintly alkaline. Filter and wash the precipitate, and add the filtrate and washings to the main filtrate on the hot plate, which is then evaporated down to about 120 c.c. Pass a current of hydrogen sulphide through the liquid, and if any precipitate is formed, filter it, and wash with water. Make the liquid acid with hydrochloric acid, and boil for 20 minutes. Then make alkaline with ammonia and add 30 c.c. of a 10 per cent. solution of ammonia oxalate; boil for 15 minutes. Filter, well wash the precipitate with very dilute ammonium oxalate, dry and ignite strongly in a platinum dish. It will be found that the foot blowpipe is necessary. Weigh the residue, and this weight multiplied by 100 gives per cent. of lime.

Sulphur.—Any of the well-known methods for determining sulphur in iron are applicable. Some of these methods look rather formidable, but are easily carried out. With a little experience a complete determination of the constituents in annealing ore may be made in 3½ hours.

Oil Fuel for Open-hearth Furnaces.

The use of oil as fuel in open-hearth furnaces is growing in the United States. One company is applying this method of firing in its two new 80-ton open-hearth furnaces recently completed, and has also equipped its remaining 50-ton furnaces with oil-burning devices. Producer gas was formerly used. The company has been obtaining very satisfactory results with the oil fuel in its melting operations.

Business Methods for the Ironfounder.

Pattern and Manufactured Stock Records.

By Percival P. Richards, A.C.A.

Lack of system in regard to pattern records and the arrangement of pattern stocks is the cause of much annoyance to the foundry manager, to say nothing of the time lost by moulders when waiting for patterns, and the waste occasioned by casting from obsolete patterns. The pattern stores should never be far removed from the moulding floor, and should be divided into two parts, one part for wood patterns and the other for metal patterns; if the requirements of the foundry are sufficient to warrant it, there should be two separate stores, one for each class of pattern. No drawing should be allowed to leave the drawing office until a serial number has been affixed, and this number must appear on the completed pattern. If the pattern is of wood the number can be clearly painted on or branded into the pattern. If it is of metal, then the number can be cast into the pattern, or into every part of it, when the pattern is made in several sections.

A simple and useful way of recording these numbers is for the drawing office to issue each order to the pattern foreman in the form of a card showing on one side full particulars and measurements of the pattern, together with a small sketch (for purpose of future identification), the number appearing in plain figures in the top left-hand corner of the card. The following design for the pattern order form is recommended:—

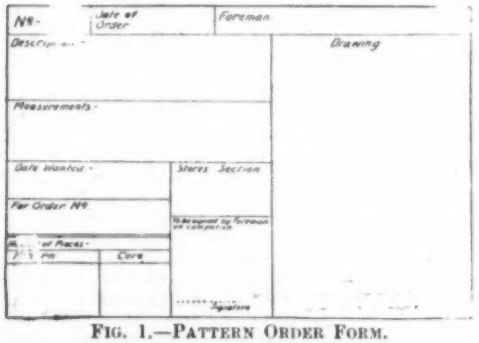


FIG. 1.—PATTERN ORDER FORM.

The reverse side of the card can be ruled to show when and for what orders the pattern is used, the store-keeper entering details each time the pattern is sent out or received by him.

Upon completion of the work in the pattern shop this pattern should be handed to the pattern storekeeper. The storekeeper will thus be able to trace any patterns not returned to him, and to ascertain from his records whether any particular pattern is in or out of store. For every pattern in stores, the storekeeper should have a card similar to the above, the set being arranged in the form of a numerical card index, that is, with the numbers running consecutively. Requisitions for patterns should always be accompanied by the pattern number. It is an advantage to have a duplicate card index with the cards classified according to the kind of casting represented, and for this purpose the name of the firm for whom the pattern is used should also appear on the card. This duplicate index may for convenience be kept in the manager's office, ready for instant reference whenever required, and in this case the

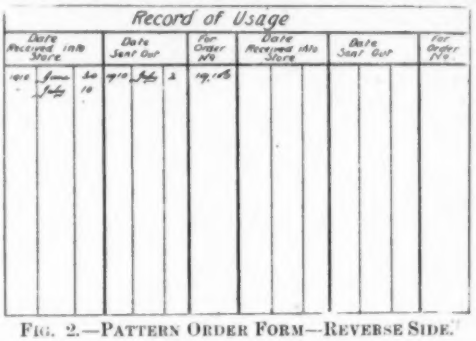


FIG. 2.—PATTERN ORDER FORM—REVERSE SIDE.

reverse side of the card can be utilised to show the cost of making each pattern. The following ruling will cover these requirements:—

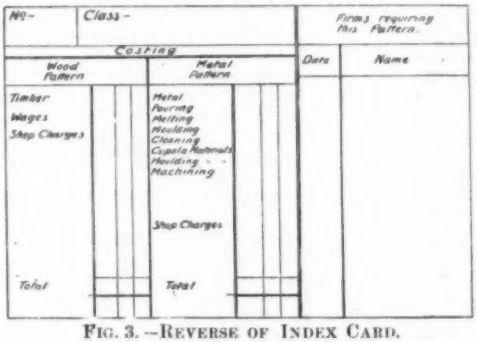


FIG. 3.—REVERSE OF INDEX CARD.

The pattern stores should be divided into sections to correspond with the classification of these cards, each pattern being placed in the appropriate section of the store, the number or letter of such section noted on the card in the space provided. When a pattern is superseded by a new or improved one, the old pattern should either be discarded and removed from the store, or if it is not desirable to do this, a large cross or other distinguishing mark should be clearly painted on it in red, in order to avoid any possibility of the old one being used when the new one is required, and the remark "Superseded by No. —" should be boldly written across the face of the index card. The card index should always be placed in a safe each evening, as the loss by fire of such a record would seriously affect the business.

In order to prevent delay in the foundry, the pattern storekeeper should be supplied each morning by the foreman and the manager with a list of patterns required for use during the day, in order that he may have them ready as soon as they are required, and it should be a rule that patterns must be returned to store as soon as they are finished

with in the foundry. This would obviate the risk of damage likely to be caused by having patterns lying about.

Manufactured Stock Records.

All castings made can be divided into two classes, as follows :—

(1) Those made to special orders and invoiced out upon completion.

(2) Those made from stock patterns and held in stock to meet general orders.

Castings under the first heading do not pass into stock, and no special records are required, but in the case of castings under the second heading it is advisable to keep records showing the quantities (and weights) made and sold, and the balance remaining in stock of each kind of casting, for the following purposes :—(1) To check the stocks on hand shown at stocktaking. (2) To prevent stocks getting too low or accumulating unduly. (3) For purposes of easy reference by the management in executing orders and in issuing directions for castings to be made. (4) To provide records of stock on hand which can be used in the preparation of interim trading accounts, without the trouble or delay of actually taking stock.

The best time to institute a system of stock records is immediately after the annual stocktaking, as complete details of the actual stock on hand at a given date will then be available. The items in the stock book should be divided into a certain number of main classes or grades, which will naturally vary according to the class of work done in each particular foundry. The following list of divisions may be taken as an example :—

(1) Very low-grade castings, such as railway chairs and other machine-made castings.

(2) Low medium grade, such as ordinary pipes of small diameter. Colliery and other plates (plain) and castings of a similar kind.

(3) General castings.

(4) Special loam castings, such as machined engine parts, special pipes, etc.

The system of grading may be based upon the amount of skilled work and supervision required in production, as the division when fixed will form the basis of departmental manufacturing accounts (to be referred to again later). Having classified all the manufactured stock on hand, the items should be transferred to stock cards, different coloured cards being used for each division, thus :—Class I, white cards; Class II, yellow cards; Class III, blue cards; Class IV, pink cards; and so on. The stock card should be designed so that the heading shows all details necessary for identification and reference, the rest of the card being ruled with three columns, the first column for castings produced, the second for sales, and the third for the balance of stock in hand, both sides of the card being so ruled.

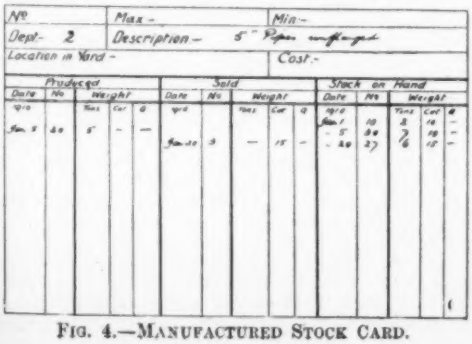


FIG. 4.—MANUFACTURED STOCK CARD.

Each card should be numbered, the maximum and minimum quantities of each casting to be kept in stock being noted thereon by the management.

A separate card is taken for each article or number of articles of the same kind, and the particulars inserted from the stock book. It is assumed that the stock in the yard is kept properly sorted in spaces reserved for that purpose, the location being noted on the card. The actual cost cannot be entered, owing to the fluctuations in the price of metal, but an average price of iron can be taken (including carriage to works) and the cost entered on that basis. When quoting or invoicing, reference to the stock card will give a price which only requires adjustment according to the market price of a metal in order to arrive at the actual cost on which to base the selling price. When finished castings are added to the yard stock (as shown in the daily production book), the number of pieces and weight should be entered in the "produced" column and the "stock" or "balance" column altered accordingly. When castings are sold, as denoted by entries in the sales day book, corresponding entries should be made in the "sold" column, the "stock" column being again adjusted. In this way the stock column will always show the actual stock in the yard ready for sale. In the example shown above it is assumed that at the annual stocktaking there were 10 lengths of 5-in. unflanged piping weighing 2 tons 10 cwts. in all, that on January 5 20 lengths were cast and added to stock, and that on January 20, three lengths were sold, leaving 27 lengths, or 6 tons 15 cwts., in stock. If this principle be adopted in regard to all the kinds of castings carried in stock it follows that the stock cards will always show in a form ready for instant reference, the whole of the stock of manufactured goods on hand; and when written up daily the amount of clerical labour involved is only small. The cards should be properly classified and indexed, the whole set being kept in a small cabinet made for the purpose.

A small section of the cards can be taken each week and checked in the yard with the actual stock on hand in order to trace clerical errors, or, what is more important, to prevent stock being sent out without being charged to customers. This method will also bring to light any manipulation in the wages by the representation that more castings have been produced than is really the case. When it is desired to ascertain the total manufactured stock on hand for the purpose of interim trading accounts or monthly financial statements for board meetings, the costs as shown on the cards can be adjusted according to the market price of metal (as already explained) and the value of the weights on hand calculated from the cards.

At the annual stock-taking the stock lists should be checked with the balances showing on the cards, and any small differences in weights (which may be due to fractions throughout the year), should be rectified on the cards. The cost of making as stated on the cards should also be revised after stock-taking. There should be no serious discrepancies between the two records, if stock is verified with the cards in sections regularly as suggested. In some cases it may be convenient to use the reverse side of the stock card as a costings card, thus combining the two, but if this be done the costings form should be ruled with, say, three columns in order that the costing may be revised without spoiling the whole card (see June issue of this journal for costings form). Revision in costs will be required whenever a rate of pay for the work is altered, or an improved method is introduced, which reduces some of the costs. In any case the costings will require revision annually owing to the alteration of the percentage added to cover trad-

ing charges in accordance with the figure shown on the annual trading account.

It should be the duty of the clerk in charge of the stock records when entering up the cards, to see that the balance of stock shown is not above the maximum or below the minimum noted thereon as fixed by the manager. When this does occur in regard to any item of stock, the card should be placed before the manager, who can then issue the necessary order, either to cease casting or to increase the production of the article concerned. In this way stock can neither accumulate unduly nor run too low without the matter being immediately brought to the notice of the management.

Engineering Exhibition at Manchester.

THE exhibition of engineering plant promoted by the proprietors of the "Engineering Review" was opened on October 14 in the City Exhibition Hall, Manchester, by Sir George Reid, High Commissioner of Australia. Nearly all the leading firms of the United Kingdom are represented, and in many respects the exhibition has an international character. Prior to the opening ceremony a luncheon was held at the Midland Hotel, presided over by Sir William Bailey. Those present included the Lord Mayor (Mr. C. Behrens), the Mayor of Salford (Mr. J. Snape), Mr. John K. Bythell (chairman of the Manchester Ship Canal), Professor J. T. Nicholson, Mr. J. A. F. Aspinall (president of the Institute of Mechanical Engineers), Mr. W. T. Stubbs (chairman of the Manchester Chamber of Commerce), and others. Sir William Bailey again occupied the chair at the opening ceremony in the Exhibition Hall. Sir George Reid said it was rather a remarkable thing that Manchester, the centre of the most thickly populated district, and possessing the most scientifically industrious population in the whole world, should not have had a similar exhibition earlier. He looked on the exhibition as likely to produce great results. They had a magnificent position in the world to-day, a position which they had gained by a marvellous development of scientific knowledge as applied to manufacturing processes. Science was a grand thing, but unless they linked it up with the active industrial forces of mankind it remained an affair more of the study and the university than of real life. While they in Lancashire had reason to be proud of what they had done, they could not retain their supremacy unless they redoubled their search and experiment.

The "Incanto" Oxy-Acetylene Welding System.

The "Incanto" low-pressure oxy-acetylene system of autogeneous welding affords a method of dealing simply and economically with an immense variety of metallurgical operations. Acetylene gas is nearly as heavy as air, its density being 13 where air is taken at 15. It is an endothermic gas which is decomposed at the moment of combustion into its elements carbon and hydrogen, and by this decomposition alone about 300 B.T.U. are generated per cubic foot of the gas. The remaining heat is furnished mainly by the combustion in oxygen of the carbon into carbon-dioxide and in a lesser degree by the combustion of hydrogen into water vapour, the total heat generated per cubic foot of acetylene being about 1,500 B.T.U. Theoretically 2½ volumes of oxygen are required for the complete combustion of 1 volume acetylene. In practice, however, with the oxy-acetylene blowpipe it is found that the best welding results are obtained with 1.7 volumes of oxygen to 1 volume of acetylene.

The flame thus produced has in its centre a small white cone at the apex of which the temperature is about 6,300 degrees Fahr. This flame consists almost entirely of carbon monoxide, which is being converted at its extremity into carbon-dioxide. Round the flame is a relatively cool jacket of hydrogen, which, not being able to combine with oxygen at the very high temperature in the immediate neighbourhood of the flame, remains temporarily in the free state, and thus protects the inner zone from loss of heat whilst excluding the possibility of oxidation, which is a difficulty other methods of welding have to contend with. Autogeneous welds can, therefore, be effected by means of the oxy-acetylene blowpipe without any deleterious effect upon the metal. The heat, in addition to being greater than that obtainable from any other blowpipe system, is also more concentrated, whilst the flame being luminous, and in the form of a short, steady jet, very little practice is required to make an unskilled workman proficient in the manipulation of the blowpipe.

In the "Incanto" system the acetylene is supplied by means of a patent generator, with purifier.

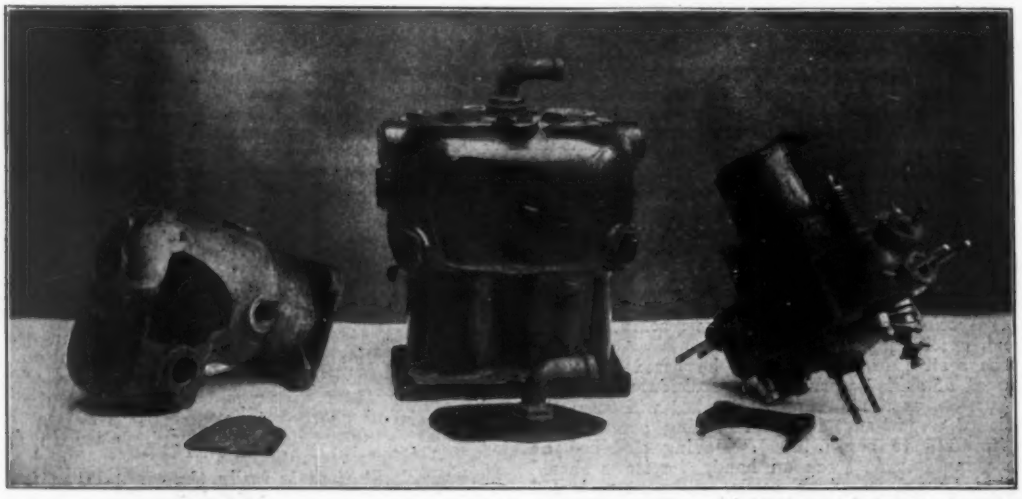


FIG. 1.—MOTOR CYLINDERS SUCCESSFULLY WELDED BY THE OXY-ACETYLENE BLOWPIPE.

A special blowpipe, which employs the injector principle, is used. The gases are well mixed in the injector chamber before they issue from the nozzle of the blowpipe, and the nozzle itself is so constructed that carbonaceous deposit in the orifice is entirely obviated.

The generators used are suitable for general lighting, oxy-acetylene welding, metal cutting, and many other purposes. They are automatic and can be left charged, ready for use, for any length of time. The gas can be used with the same facility as with a town coal-gas supply, and the pressure is always constant and only sufficient for perfect combustion.

Fig. 2 shows an automatic regulator, recommended for welding and cutting work. It will deliver the high and varying oxygen pressure from the cylinder at any required low pressure from zero to 80 lbs. per square inch. This latter pressure cannot be exceeded, as the safety valve then opens and releases the gas. The pressure at the outlet of the regulator is registered on the low-pressure gauge at top and with the blowpipes this should vary between 10 lbs. per square inch for the smallest size and 30 lbs. per square inch for the largest. The pressure can be adjusted by unscrewing the thumb-screw on top to reduce, or by screwing it down to increase the pressure. The tap controls and shuts off the supply of oxygen.

FIG. 2.—OXYGEN PRESSURE REGULATOR.

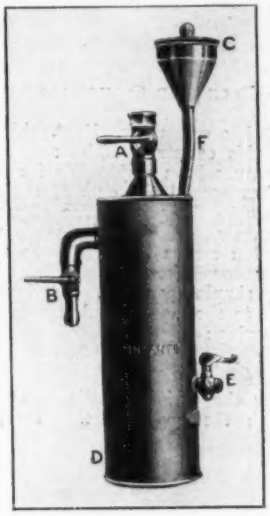


FIG. 3.—SAFETY VALVE.

With the injector type of blowpipe, where acetylene is drawn direct from the generator, or from an intermediate gas-holder, the use of the hydraulic safety valve shown in Fig. 3 is a desirable precaution. It must be fixed on the acetylene supply pipe in a vertical position, and as near to the blowpipe as possible. In cases where two or more blowpipes are worked from the same acetylene supply, a separate hydraulic valve should be employed for each. The hydraulic valve precludes the possibility of oxygen at any time flowing back along the acetylene supply pipe. Its action is apparent from the illustration.

The acetylene pipe from the gas-holder is connected with the branch A, and the acetylene pipe leading to the blowpipe is connected to the branch B. C is a loosely fitting lid through which water can be poured into the chamber D until it overflows at the tap E. The tap at A must be closed whilst the chamber D is being filled with water. When water shows at the tap E it must be closed, the lid C must be replaced and the tap at A opened. The valve is then in working order. The filling pipe F is made long enough to hold a column of water equal to the pressure of the acetylene holder, which should be about 12 inches of water. The supply of acetylene to the blowpipe may be regulated by the tap on the branch B (where taps do not exist on the blowpipe itself), and the tap at A may be left permanently open. Should the blowpipe nozzle at any time become choked whilst the oxygen supply remained unchecked, this gas would be forced by its superior pressure along the acetylene pipe. The back-pressure thus caused acting on the surface of the water in the chamber D would force this water up the pipe F, displacing the lid C. The hydraulic seal would thus be destroyed, and both gases would escape into the atmosphere until the taps at A and B were closed, thus oxygen can never penetrate the acetylene supply pipe beyond the tap of the hydraulic valve.

Fig. 1 illustrates some examples of work for which this blowpipe is well adapted. As regards cost, much depends on the nature of the work and the capacity of the workman, but it is claimed that the system generally compares very favourably with the cost of most riveted or brazed jobs.

It is not claimed that the system will supersede ordinary forge welding where that is applicable, but the blowpipe is such a clean, convenient and portable tool that it enables a large variety of difficult welding to be done *in situ*, where riveted or brazed joints would otherwise be necessary. It, therefore, greatly extends the scope of welding.

Some idea of the strength of an oxy-acetylene blowpipe joint may be gathered from the fact that bars of Staffordshire iron fused together by this system have given tests of over 29 tons per square inch at the point, and plates of iron and steel varying in thickness from 20 gauge upwards when welded together by the blowpipe have proved stronger at the joint than in the body of the plate.

Foundry Plant and Equipment.

Modern Coremaking Machines.

The coremaking machines on the market at present consist chiefly of the kind that make straight cores whose section is formed by various shaped dies, such as the round, square, and slab designs, and that they do splendid work is well known, but their limitations are just as well known; so that we are compelled to look further for machines that are capable in the hands of men who are not necessarily coremakers, of producing any class of work in quantities.

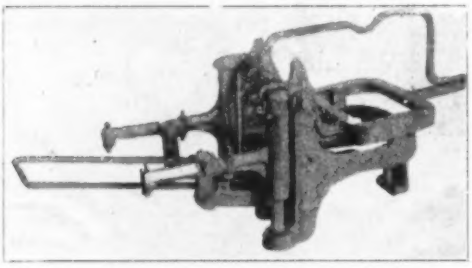


FIG. 1.—ROCK-OVER CORE-MOULDING MACHINE.

Complicated cored work, if anything, is on the increase in this country. The automobile industry has in a measure been responsible for a class of core work that has opened the eyes of the manufacturers in other lines to the possibilities of making castings in one piece, that were usually made up of several. This very often means that the bulk of the work is thrown on the coremakers, the moulding being in many cases, a very simple operation. The types of machines best adapted to the many requirements of coremaking are the following:—

Stripping Plate Machines.

By making the dividing walls of any core box to strip through the body of the core, it is only

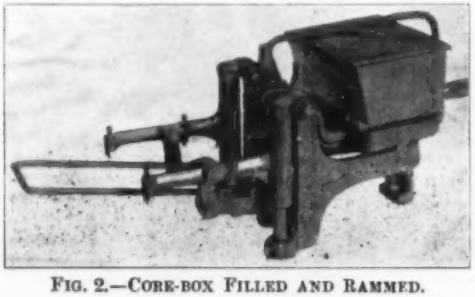


FIG. 2.—CORE-BOX FILLED AND RAMMED.

necessary to fasten the walls to the stripping plate, leaving the body of the core box on the table. Of course, this would mean a considerable first cost, but on repetition work it pays to spend money liberally on any "rigging" that will materially decrease the cost per piece.

On such castings as motor car and motor boat petrol engine cylinders, carburettors, pump cylinders, valve chambers with internal dividing walls of thin section and where one part of the core must be relatively correct to its adjoining and connecting parts, it will be found that by making the dividing walls of any core box to strip through the body of the core it is only necessary to fasten the walls to the stripping plate, leaving the body of the core box on

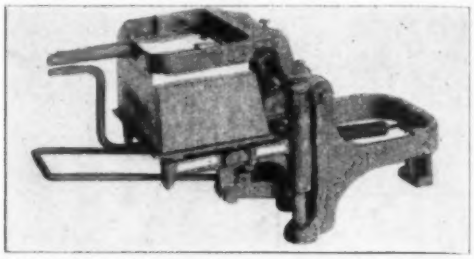


FIG. 3.—BOX ROCKED OVER TO DRAWING POSITION.

the table, so that it can be turned over and lifted off the core by hand.

Rock-Over Drop Machines.

For halved work other than that of the repetition variety, where the bulk of both box and core is such

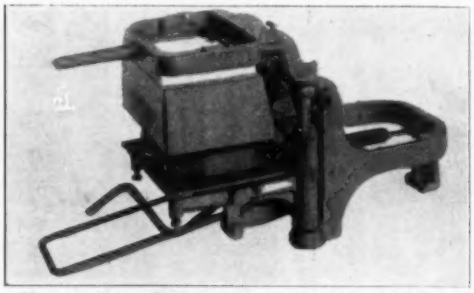


FIG. 4.—CORE DRAWN DOWN OUT OF THE BOX.

that it is difficult for one man to handle, the rock-over drop machine is well adapted, by fastening the bottom of the box with wood screws to the pattern plate end, using that as a bench when ramming. In fact, by releasing the hook at the side of the machine, and

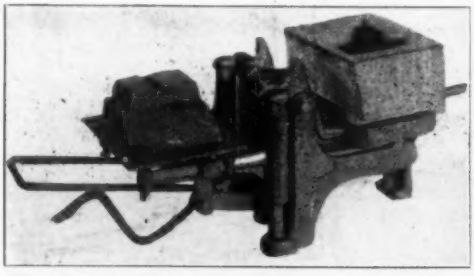


FIG. 5.—BOX RETURNED READY FOR NEXT CORE.

pumping the handle up and down, a jarring effect results, thus aiding the initial ramming very materially. After the face of the core is struck off, a core plate is placed in position, the clamp-bar brought over and the whole rocked over on flask rests,

the clamp-bar is dropped and simultaneously the foot lever is operated and the back of the pattern plate is tapped with a wooden mallet, the core leaving the box perfectly and resting on the core plate ready for the oven. This method of making cores is claimed to have no superior, as no special rigging is needed. Perfect cores are made, without injury to the core box. Further, these machines, when not used on coremaking, are very useful in making moulds, such as "flatbacks," when used singly, or almost any class of work when operated in couples.

Jarring Machines.

On large work that ordinarily demands the services of two or more men the plain jarring machine is very effective in cutting down the cost of ramming, as once the sand is in the core box, which should be banked up above the surface for several inches, it is only necessary to turn on the air, and the machine will do the rest. It is not necessary to fasten the box in any way on the plates, as the jarring action affects the sand only, and rams so perfectly that all that is necessary is to strike off the face and be ready for the turnover, which in this case is usually accomplished by using a crane, trunnions or slings being fastened to the box previous to beginning operations.

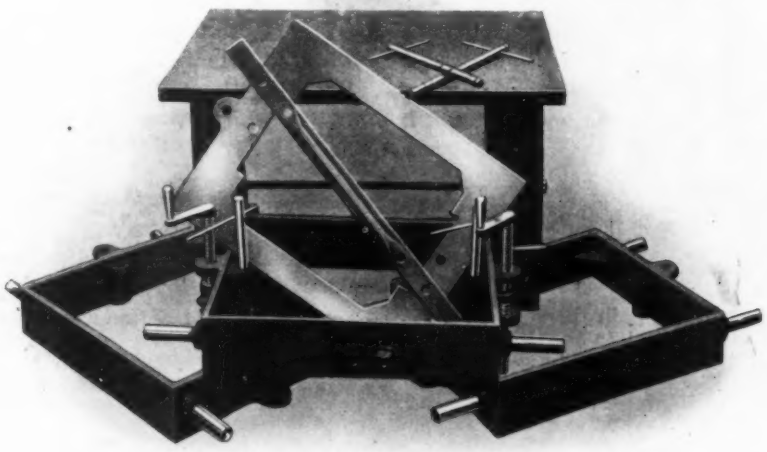
The Pridmore Rock-Over Machine.

This machine, shown in the accompanying illustrations, is manufactured by Henry E. Pridmore, of Chicago, U.S.A. Fig. 1 shows the machine without the drier plate or core box in position. In Fig. 2 the core box has been set on the table, the core rammed with the plate in position, and the clamping rod adjusted, ready for rocking over the core. Fig. 3 shows the core rocked over and the plate in position on the equalising pins. Fig. 4 shows the clamping rod lowered, and the core dropped away from the core box. In Fig. 5 the core box has been rocked back and the core is shown on the drier plate ready to be carried away. The core box is in position for making the next core. The entire machine is a small model of the Pridmore rock-over moulding machine, and the operating mechanism is similar in every way to that of the larger moulding devices. Its use is claimed to effect great economies in the production of cores, as the output is materially increased and the cores are truer to pattern than when made by hand on the bench.

The "Coventry" Pattern-Plate Apparatus.

The pattern-plate apparatus shown in the accompanying illustration meets a distinct want in foundry equipment, particularly in those shops which do a variety of jobbing work. A jobbing foundry that only has an order for 100 castings off a pattern cannot generally afford to make machined pattern-plates, and even the largest foundry has many jobs that will not pay to put on a moulding machine, unless the pattern plate can be made in a quick and inexpensive manner.

The "Coventry" pattern plate apparatus is designed to enable a moulder, in a few hours, to make a double or single sided pattern plate, which will accurately fit the machine and the boxes. These plates if made in non-shrinking white metal, can be scraped up and finished ready for use by the same moulder in a further few hours; and when the plate is obsolete, the metal can be used again, leaving only the moulder's time to be charged against the last job. The makers of the apparatus are The Britannia Foundry Company, Coventry.



THE COVENTRY PATTERN-PLATE APPARATUS.

Some German Moulding Machines.

Hydraulic Moulding Machine with Piston.

Herewith depicted is an universal moulding machine made by Messrs. Bopp & Reuther, of Mannheim-Waldhof, Germany. As will be seen, the machine consists chiefly of a piston K, a carriage W running above the piston, a revolving plate T carrying the two halves of the pattern, to which the hooked discs *h*

are attached, and a counterpress plate G. The machine is worked in the following manner:—In the first place an empty flask F is placed upon the revolving plate T, and another empty flask F, upon the carriage W; then the upper flask F is filled with moulding sand and the distributing valve opened in such a manner that the piston K first slowly, then quicker, raises both flasks and the revolving plate against the counterplate G, ramming the sand in the upper flask. After this, both flasks are coupled with the revolving plate T, by means of the hooked discs *h*, and the distributing valve gear reversed; the piston sinks to its lowest position, while the revolving plate and the flasks sink till they rest on the adjusting rings *s*; the revolving plate is then turned over so that the rammed flask comes underneath and the empty one on top, where it is in its turn filled with sand and rammed in the same way as the other one.

When the ramming is finished the lower flask is disconnected from the revolving plate by rotation of the hooked discs, so that it can be easily taken off from the pattern. This is done after the sinking of the piston, when the revolving plate rests on the adjusting rings. The revolving plate is again turned

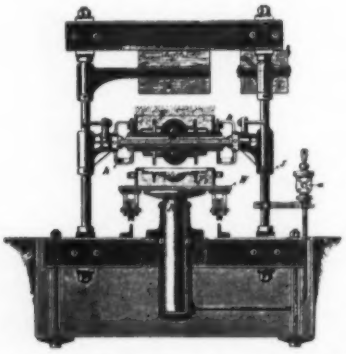


FIG. 1.—HYDRAULIC MOULDING MACHINE WITH PISTON

over, an empty flask put on it, filled with sand and the ramming is carried on as before. In this manner there is always at the rising of the piston a flask rammed and at the sinking a flask taken off, thus combining two operations in one machine.

The chief advantage of this hydraulic machine lies in its application for deep and large flasks. The hydraulic pressure is suited to the size of the flasks by the different size of the piston, giving uniformity of moulding. One of the special advantages, also, is that the revolving plate slides along two rigid columns from one end to the other. The press block is also movable so that flasks of different depths can be used.

Hydraulic Moulding Machine for Large Articles.

The machine shown in Fig. 2 is in principle the same as that shown in Fig. 1, but can be constructed with one or more press cylinders as desired. The revolving plate is firmly guided either on both sides by the rigid frame of the machine, or by slides (as shown in Fig. 1) along two or four columns, whereby uniform and exact moulding is attained. For the easy turning of the revolving plate suitable gearing is provided.

Special care must be taken as regards the coupling of the heavy flasks, and this can be effected very quickly by means of keys. The press block does not revolve, as it does in the smaller machines, but it is fixed on a shifting frame, which is in this case an upper carriage, and consequently can be easily taken out of the way of the revolving plate. These machines have been constructed to take flasks ranging up to 8 ft. 4 in. by 3 ft. 6 in. by 6 in., and 9 ft. 4 in. by 1 ft. 8 in. by 12 in.

Machine for Moulding Small Articles in Large Quantities.

In Figs 3 and 4 is shown a special moulding machine for dealing with small articles in large quantities.

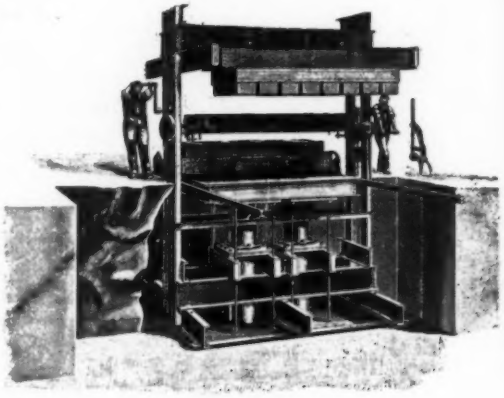


FIG. 2.—HYDRAULIC MACHINE FOR MOULDING LARGE ARTICLES.

The particular feature of this machine is that the two halves of a mould are executed by one pressure. This is done by the application of a frame R, which is rammed into the flask F. Fig. 3 shows the flask and frame without any sand in them. Fig. 4 represents the two halves of the mould with a runner passing right through, rammed and taken off. In the inset are shown the flasks placed one on top of the other ready for casting. The advantage of this machine is that the two halves of a mould can be made at one time and several finished flasks can be

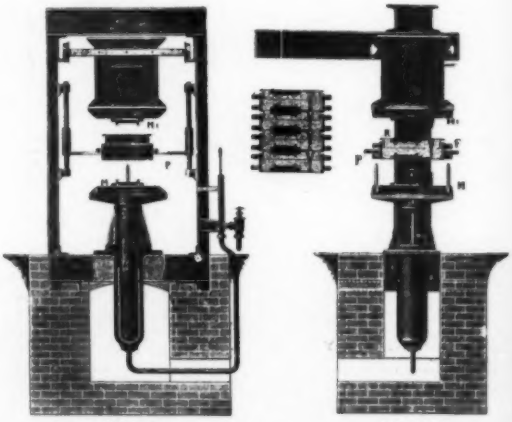


FIG. 3. FIG. 4.

MACHINE FOR MOULDING SMALL ARTICLES IN LARGE QUANTITIES.

heaped on the top of each other and then cast, giving a large economy in floor space, sand and iron.

The machine is worked in the following way:—After putting the flask F upon the lifting off frame P (Fig. 3) the pressure is put on the plunger K, until the pattern plate M touches the flask F. The

latter is then filled with sand and the frame R placed upon it. The frame R is also filled with sand. By a second application of pressure under the plunger K it is raised and rams the flask F filled with sand, and the frame R, against the pattern plate M_1 by carrying up the lifting off plate P; the pattern plate is fastened to the carriage W, and in this manner one mould is made below in the flask F and one above in the frame R, by ramming the latter into the flask. After the sinking of the plunger K the rammed flask is placed in the position shown in Fig 4, that is, taken off the patterns. The casting of these finished moulds can be done in larger numbers, as before mentioned, by placing the flasks upon one another, and by means of a runner passing right through, which is rammed in at the same time.

Core Box for a Bearing to Receive White Metal Lining.

By H. B.

In Fig. 1 is shown a main bearing pedestal arranged to receive a lining of white or other soft metal, suitable for bearings. The particular metal used is poured into the recesses formed to receive it, after a mandril has been placed in the position which the journal of the shaft will afterwards occupy. Usually these dovetailed recesses are arranged longitudinally, but by having them transverse as shown in Fig. 1 certain advantages are gained, especially if the bearing be a large one.

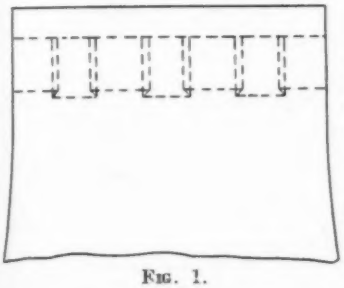


Fig. 1.

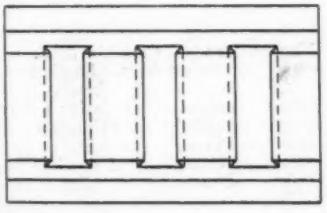


Fig. 2.

The plan is now scribed in outline on the top surface, as shown in Fig. 3, and then the pieces are taken apart. The lines on the top are continued down the sides of each block, as they appear in the side elevation, Fig. 4, the depth *f* allowing for the top print. The required shape is now carved out, care being taken to preserve the dove-tailed corners. To a skilful man this is comparatively simple.

When all the pieces have been carved out to shape and glass-papered, the box can be re-assembled, and after trimming up the sides it is ready for use. If, however, many cores are required from it, it would be as well to put a little more work into it. For

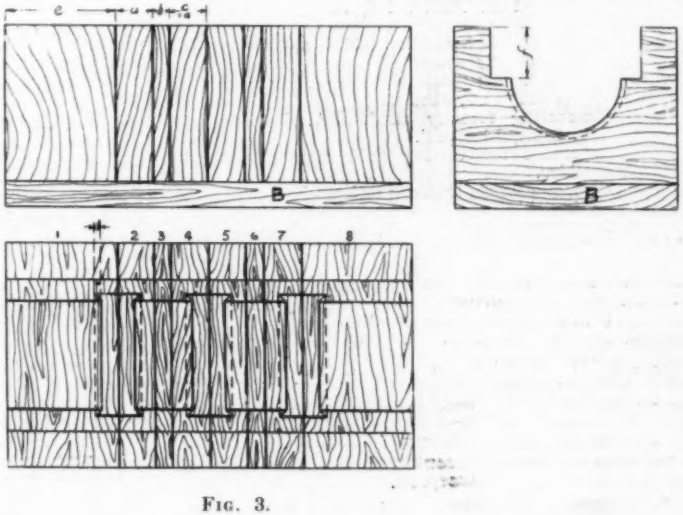


Fig. 3.

At first sight it seems inevitable that the core box should contain some rather frail loose pieces, semi-circular in shape, in order that the core may be drawn. Small loose pieces in core boxes are always objectional, and in this case a method of dispensing with these pieces which is adopted by a few engine-builders, is given below.

After the plan (Fig. 2) has been set out full size on a board, the pitch of the grooves is divided into three parts, *a*, *b*, *c*, so that the middle piece *b* is about twice the dimension *d* in width. Blocks of wood of a suitable variety are now cut to sizes as required. There will be eight pieces; two end pieces of thickness *e*, allowing for prints, four pieces thickness *a*, and two pieces thickness *b*. These are screwed close together in their respective positions, to a board B, which serves as a base, and the tops are planed up level.

instance, the wood could be of a hard variety, the blocks could be dowelled to the base, and in addition a frame could be made to hold the whole thing together. How elaborate to make it would depend upon the extent to which it is intended to use it.

The making of a core from this type of box is a very simple matter. The parts are fitted together and the box rammed up in the usual way, vents being made when necessary. When the top surface has been levelled off the box is turned upside down on to a plate, and if the blocks have been screwed to the base, the screws are removed. Then, after slight rapping, the pieces are removed in the following manner. The end pieces are drawn, first out a little to clear the dove-tail edge and then straight up. Pieces 6 and 3, which require straight upward lifts, are now removed. Lastly, 2, 4, 5, and 7 are removed in the same way as 1 and 8.

Inventions.

Applications for Patents.

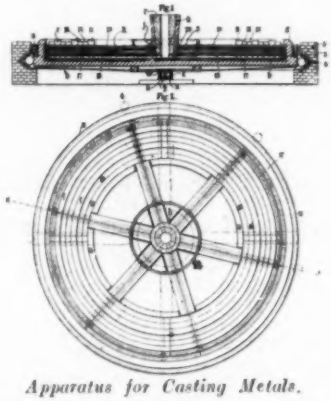
An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

20,417.*Casting machines. E. Gursch.
20,420.*Casting machines. E. Gursch.
20,488.*Means for refreshing and keeping cool the operatives employed in connection with metallurgical furnaces. E. Dor-Delattre, 24, Temple Row, Birmingham.
20,503. Furnaces. E. J. Ison and W. W. Watts.
20,871. Emery wheel for grinding or abrading purposes. F. E. Whitham.
21,603.*Process of producing metals and alloys. Ampère-Ges.m.b.H. and Pro. Dr. E. Müller.
22,010. Fluxes for refining and extracting metals. A. Gutensohn.
22,016.*Purification of magnesium and magnesium alloys. (Chemische Fabrik Griesheim-Elektron, Germany.)
22,068. Safety-guard for spindle moulding-machine. R. Johnstone, jun., and J. Love, 2, Union Place, Lochwinnock, Renfrew.
22,246. Process for annealing or softening copper, brass, or bronze wire or similar alloys. J. Maccormack and R. Miller, 154, St. Vincent Street, Glasgow.
22,581.*Process of case-hardening metals and alloys. M. Gräf and O. Peschel.
22,591. Heating and annealing furnaces. J. Jack, 15, St. James' Row, Sheffield.
22,660. Renovating foundry sand. A. Poulson, 37, Moorfields, Liverpool.
22,924.*Apparatus for casting fluid metals. H. H. Doehler.
23,262.*Drying devices, more particularly for use in drying high furnace blast. P. Würth, 37, Furnival Street, Holborn, London.
23,272.*Annealing, hardening, case-hardening, and retort furnaces. J. Zeugin.
23,429.*Rabbles of calcining furnaces. T. Edwards.
23,430.*Tilting, calcining, or roasting furnaces. (Thomas Edwards, Australia.)
23,664. Smelting furnaces. T. Hill, 75, New Street, Birmingham.
23,744. Scaling and annealing metals. S. O. Cowper-Coles and Metalloids, Limited.
23,835.*Moulds for casting tubes. H. J. Molinder.

Abstracts of British Patent Specifications recently accepted.

5,651 (1910). *Wrought Iron Annealing Pot.* E. T. Lammine, 26, Schönratherstrasse, Mülheim a/Rhine, Germany.—The subject of this invention is an improved form of the annealing pot described in the Specification of former Letters Patent No. 8,349 of 1909 in which the upper flanged or outwardly bent rim is made of an iron bar of any suitable section, and is welded to the casing of the pot. From the subject of this earlier invention, the present invention differs in that the upper separately made rim is rolled without seam from a block to the desired section, is worked (*e.g.*, it is turned so as to provide a true surface to receive the cover and thus form a substantially gas-tight joint with the cover) and then connected by welding to the annealing pot and to the carrying lugs.

18,451 (1909). *Process for Casting Metals and Apparatus Therefor.* W. B. Bary, Isaac Place, 7, St. Petersburg, Russia.—Fig. 1 is a cross section on line H J, Fig. 2, of one form of apparatus constructed in accordance with this invention; and Fig. 3 is a plan. The molten metal is cast into the runner *h*, and flows through the passages 18 into the spaces 17, and on rotation of the platform *b* the molten mass flows outwards, gradually filling the moulds from bottom to top, the gases being driven off through radially arranged passages 19 leading from the tops of the spaces 17 to vertical exits 20 near the runner *h*. When the molten metal appears in the vertical exits 20, the pouring is stopped and the rotation of the platform *b* is continued until the strips become quite hard. On stopping the rotation the wedges *n* are released and withdrawn, the bricks *k* are knocked off and the metal runners which have formed in the passages 18 are separated from the castings. One or two of the packing blocks *f* are then removed and the cooling strips allowed to contract towards the centre, the runners being previously removed. When the strips



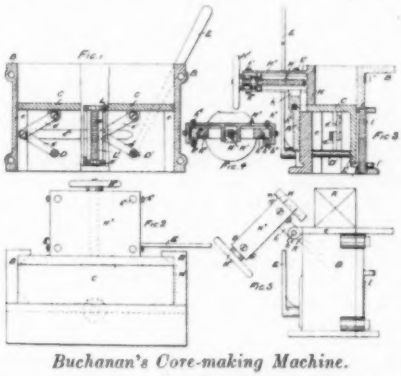
Apparatus for Casting Metals.

are cool they may be cut up and straightened out as desired between rollers. The platform *b* is mounted on an antifriction bearing composed of a pair of members *w*, *x*, one *x* of which has a central boss *y* and carries a triangular plate *z* for spacing apart the balls 2 employed. Side shaking of the platform *b* is prevented by the disposition of a ball race 3 and balls 4 in the masonry 5 of the structure at the periphery of the platform.

15,989 (1909). *Manufacture of Crucible Steel.* A. Reynolds, Birkbeck Bank Chambers, Southampton Buildings, London, W.C.—The primary objects of this invention are to minimise the loss by oxidation of alloy substances such as tungsten, added to the charge of iron or steel in the crucible, and to minimise wear and tear of the crucibles. Instead of charging the crucible with bar iron together with all or a portion of the alloying substances, the crucible is charged with a mass of steel of suitable composition, and preferably of a shape and size to fill or substantially fill the crucible, such mass of steel having a cavity in it for the reception of alloying substances or reducing agents, which cavity is then closed by means of a steel plate or plug. Blocks or billets of this character are formed (preferably with a tag or ring at their upper ends for subsequent handling) from a steel made by the ordinary Bessemer, open-hearth or electric processes, which preferably contains some silicon and manganese, which by the time the steel has solidified, will have combined with any oxides which may exist in solution in the melted steel. Such a block or billet with the alloying or reducing materials enclosed in its cavity, the opening of which is preferably at the under side of the block, is either charged cold into the crucible, or is pre-heated in a suitable furnace, in which case the block is preferably coated with clay or other suitable material, in general of similar composition to the crucible, but of somewhat lower melting point, to prevent oxidation of the steel block during the pre-heating. In either case, the upper surface of the block when in the crucible is preferably covered with slag or slag-forming materials, to protect the charge from oxidation during fusion in the crucible. This slag is preferably of a composition similar to that of

the crucible, but of course of greater fusibility. When any of the alloying or reducing materials is of such a nature as to cause the evolution of gas when the charge is heated, *e.g.*, carbon, a gas vent is provided, preferably in the plug which closes the mouth of the cavity, and this gas vent may be stopped with clay or with a readily-fusible metal or alloy.

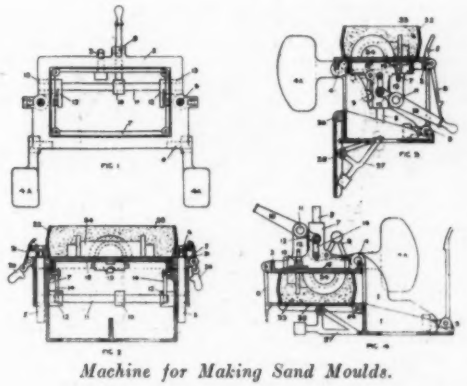
23,594 (1909). *Core-making Machines.* G. Buchanan, Foster Road, Wrexham, Denbigh.—Figure 1 is an elevation of the machine from the back, partly in section; Figure 2 is a plan; Figure 3 is a transverse section; Figure 4 is a section on line *x*—*x*, Figure 3; Figure 5 is a side elevation showing the position for the removal of the core A. The machine is constructed with a frame B, in which a ram or pusher plate C is moved up and down by the cranks D D^1, connected thereto by links *d* d^1 and connecting strip d^2 to give it a parallel movement. To ensure a truly vertical movement of the pusher plate C, it is provided with corner guides *c*, which move up and down the inside machined surface of the frame. One side of the frame is cut away, and is replaced by a movable or adjustable side H, which can be moved horizontally across the face of the pusher plate by the screw H^1 operated by the hand wheel H^2. The adjustable side H is supported or carried by a bracket *h* hinged to a lug or projection h^1 on the side of the pusher plate C, so that the adjustable side will move vertical with the pusher plate C. A guide arm or bracket K extends below the supporting



Buchanan's Core-making Machine.

bracket *h*, and rests against the lower part of the side frame to maintain the adjustable side H vertical until the ram or pusher plate C is raised to its full height, when the guide arm K is free to swing into the interior of the frame or core box below the plunger or pusher plate C, and the adjustable side H to swing backwards clear of the plunger, as shown in Figure 5. A parallel movement of the adjustable side H is obtained by V slides h^2 working in sleeves h^3, these slides being adjustable by the set screws h^4. If so desired, however, the V slides may simply work in the interior of the supporting bracket. The screw H^1 and slides h^2 are covered and protected from dirt and sand by a suitable outer cover or casing H^3 affixed to the supporting bracket. The vertical adjustment of the plunger or pusher plate C is obtained by a screw *l* fitted into a slot L in the one side or end of the frame or box. The screw *l* carries a nut l^1 which is raised and lowered by the rotation of the screw *l* or by the rotation of the nut l^1 about the screw *l*. A lug or projection L^1 on the underside of the plunger or presser plate C comes to rest upon the nut l^1 when lowered, so that the extent of the downward movement of the plunger C is regulated by the position of the nut l^1. The plunger C is always raised to the top of the frame or core box by the handle E, and with it the adjustable side. When a change of size or core is desired, the nut l^1 is raised or lowered the desired extent to give the depth of box required above the plunger C, and by the side screw the adjustable side H is moved to and from the fixed side to give the width required.

10,328 (1909). *Machine for Making Sand Moulds.* A. W. Brown, Ellerslie, Oswald Road, Chorlton-cum-Hardy, Manchester.—Figure 1 is a plan of the machine with the pattern plate removed, showing the pattern slide, and the shaft cranks and handle for moving same; Figure 2 is a longitudinal section through the machine, showing the pattern plate with a pattern on same, and a moulding box in position with the sand rammed in it, ready to be turned over for withdrawing the pattern; Figure 3 is a transverse section through the machine, showing the various parts in the same position as in Figure 2; Figure 4 is a transverse section through the machine, showing the frame (carrying the pattern slide, pattern plate, and moulding box) turned over. The shelf is shown raised for the mould to rest on when released from the frame, and all in readiness for the patterns to be withdrawn from the mould. The frame 2 is secured firmly in place by the catch 3 face upwards, which operation forces the pattern plate 15 level with the face of the frame. When the pattern plate is level with the face of the frame the catch 8 drops into place against the handle 10 preventing this from moving. This catch takes the place of a locomotive latch which has been used for a similar purpose. As the handle 10 is connected by means of shaft 11 cranks 12 and links 14 to the slide 7, which carries the pattern plate, neither of these can move until the catch is released. A moulding box 32 is then placed over the projections 6 on the spindles 5, and clamped down by the clamps 30—31;



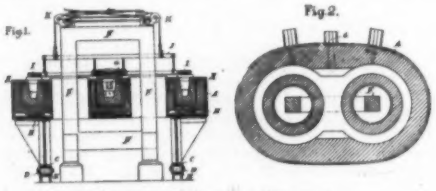
Machine for Making Sand Moulds.

sand 33 is then filled into the box and rammed firmly around the patterns 34. The catch 3 holding the frame is then released, and the frame and moulding box turned over together on the hinges 4. The pattern plate 15 and slide 7 are still securely held in position by the catch 8, so no movement of these, relative to the frame, can take place. The shelf 35 is then raised to a horizontal position and held there automatically by the catch 37. The catch 8, which up to that time held the pattern plate from moving, is then reversed, and serves to hold the frame and the shelf together, leaving the pattern slide and plate free. Air is then turned on the vibrator 19, and the pattern plate and patterns raised away from the mould by means of the handle 10, shaft 11, cranks 12, and links 14. Another catch, 9, then drops into place and holds the pattern slide in its new position, *i.e.*, with the patterns withdrawn from the mould. The clamps holding the moulding box are then loosened, releasing the mould from the frame. The catch 8 is removed from the shelf, releasing the frame and allowing it to swing to a vertical position, while the mould remains on the shelf The catch 9 drops out of the way and allows the pattern plate to be moved to its original position—level with the face of the frame.

22,201 (1909). *Manufacture of Iron and Steel.*—B. Talbot, County Bank Chambers, Middlesbrough.—The advantage of both the Bessemer system of oxidising certain impurities by air blast, and of the continuous system, are utilised to effect a preliminary refinement of crude metal before same is eventually passed to the

finishing furnace, in which the final purification is effected. A converter of large capacity, say 50 or 100 tons, is employed, which is preferably lined with magnesite or other basic material, so that an oxidising and basic slag may be produced and used without unduly damaging the lining. Assuming that it is desired to treat a 50-ton charge of molten metal containing about 3.7 per cent. carbon, 1.25 per cent. silicon, and 0.8 per cent. manganese, about one-half, say 25 tons, of the metal is run from the blast furnace into the converter, in which it is blown by what is initially a surface blast, and under which the charge is treated until the silicon has been oxidised down to about 0.25 per cent. or under, the manganese to about 0.5 per cent. or even to traces and the carbon reduced to about one-half to two-thirds of what was originally contained. One of the advantages of this treatment is that all or practically all of the carbon remaining, of which about 1 per cent. may have been originally in the graphitic form, is converted into combined carbon, and the foaming or even the explosions due to a graphitic form of carbon in the subsequent treatment in a finishing furnace is avoided. When the above result has been attained the remaining half of the charge, say a further 25 tons, of impure metal, is run into the partially purified bath, and the combined metal is again blown until say the silicon has been reduced to 0.25 or under, the manganese to 0.5 or even to traces, and the carbon has been practically all converted into its combined form and its percentage is about 2.75 under. The bath is then ready for tapping, and the metal may be run into the finishing furnace. The blowing is effected at a comparatively short distance below the surface of the metal, a general disturbance of the body of the metal following. Such surface blowing enables a low pressure to be used, and produces in the first instance a considerable oxide of iron slag, eliminates or partly eliminates the silicon by oxidation and part of the carbon, while the subsequent addition of impure metal reacts on the oxide of iron in the slag present, thus recovering some of the iron. The further blow in the converter oxidises the impurities to the desired extent, and the transfer of the whole or a part of the metal to the finishing furnace is effected with a considerably hotter metal than hitherto.

24,302 (1909). *Electric Induction Furnaces.* A. Hiorth, 19, Josefinegate, Christiania, Norway.—Figure 1 is a longitudinal section through the furnace; Figure 2 is a horizontal section on the line II—II of Figure 1. The



Electric Induction Furnace.

body A of the furnace, in which have been provided two annular channels communicating at the middle, is supported by a frame formed of two sets of beams B. Below these beams is arranged, at each end of the furnace, segments C supported by means of rollers D, on the guides E which again rest on the foundations. The iron core F is mounted on frames between the guides, independent of the supporting frame of the furnace. This arrangement enables the furnace to be tipped without moving the iron core with it. The primary winding of the furnace is composed of four disc-shaped coils H H and I I. The former two are mounted in the body of the furnace below each annular channel. The latter coils I I, are suspended above the annular channels from a frame J, which can readily be raised or lowered by a lifting device K mounted on the iron core. The coils do not quite cover the connecting portion of the two annular channels, so that at this point, on both sides, the necessary operations with the molten mass, the cleaning and the charging can be effected without difficulty. The primary winding is in four parts so that the spreading of the lines of force will only amount to one-quarter of that occurring in the ordinary arrangement of the winding with two coils. In employing the disc transformer winding, so much room can be left free without impairing the efficiency of the transformer between the vertical portion of the iron core and the inner walls of the furnace, as to enable the furnace (with fixed iron core) to be tipped sufficiently.

The F.T.J. Bookshelf.

Iron and Steel Analysis.—Vol. I.

By A. Campion, F.I.C., F.C.S., etc. Glasgow: Fraser, Asher & Company, Limited, 164, Howard Street.

This little volume is a standing tribute to the author's capacity for précis writing, for in the space of 76 small pages he details the procedure for analysing iron and steel for all the ordinary constituents, as well as the analysis of coal and coke; while in addition he gives some notes on re-agents and the preparation of solutions. As is explained in the preface, this text-book has been prepared primarily for the use of the author's own students, but more especially for those who can only attend classes in the evening, and to whom the usual text-books on iron and steel analysis are unsuitable, giving as they do a multiplicity of methods. In the book before us, except in a few instances, only one method is given for each constituent, those being the methods which the author has had in constant use for the past sixteen years, and which have proved to be both accurate and rapid. In each instance the procedure is plainly set forth, in such a way that even the early student of chemistry should have no difficulty in thoroughly understanding it; and this fact should recommend the book particularly to those not well versed in laboratory practice. The iron and steel chemist, too, should find such a compact work of reference of great utility in every-day work.

Hand-book for Ironfounders.

Issued by the Frodair Iron and Steel Company, Limited.

This hand-book, which we reviewed in our issue of September, is now being published by Messrs. E. & F. N. Spon, Limited, 57, Haymarket, London, W.

Mr. George Senior was on October 4 installed Master Cutler of Sheffield. Alderman Senior, addressing the members of the company, deplored the lack of funds which crippled the efforts of the company to prevent false marking of steel goods. Within recent years they had spent nearly £2,000 for the protection of the word "Sheffield" abroad. Action had been taken in Egypt, Canada, France, and Germany, and action was being taken in the United States. He did not think that, as a large manufacturing city, Sheffield was holding its own as it might do, and this might be partly because they were allowing other nations to trade on the name of Sheffield. Before the installation of Alderman Senior, a special meeting of the Company was held, at which two new members were elected. A vote of condolence was passed with the widow and family of the late Mr. R. G. Holland, an ex-Master Cutler, and Mr. William Wilkinson Wood, jun., of the Wardsend Steel Company, was elected to fill the vacancy caused by his death. The resignation of Sir Joseph Jonas was received, and his son, Mr. Robert Jonas, was elected in his place.

Trade Talk.

A RECEIVING order has been made in connection with the affairs of Mr. Wilfrid Pedley, ironfounder's manager, of Willenhall, Staffs.

THE business of Mr. J. F. S. Adams, engineer and mill furnisher, 43, Old Sneddon Street, Paisley, has been transferred to Mr. J. M. R. Forrester.

THE BRITISH ENGINEERING INDUSTRIES COMPANY, 24, Linthorpe Road, Middlesbrough, are opening a warehouse and show rooms in connection with their business.

TAYLOR, LAW & COMPANY, LIMITED, of the Anchor Works, Adams Street, Birmingham, have appointed Mr. T. L. Ewing as one of their North of England agents.

MESSRS. T. and E. WANNBACHER, British representatives of the Armaturen und Maschinenfabrik A.-G., Nuremburg, have removed to 5, Appold Street, London, E.C.

THE purchase of the Queen's Ferry Works of Willans & Robinson, Limited, is at present under option to a syndicate, for which option a substantial sum has been paid.

THE STIRLING BOILER COMPANY, LIMITED, and the British Welding Company, Limited, have moved their London offices from 25 to 58, Victoria Street, Westminster, S.W.

MESSRS. ELCOCK & SONS, coppersmiths, metal spinners, etc., Tindal Works, Birmingham, have severed their connection with their Scottish agent—Mr. M. B. Patterson Barrhead.

THE ENGINEERING STANDARDS COMMITTEE have recently issued the British Standard Specification for Structural Steel for Shipbuilding, which has now been revised for the second time.

MESSRS. HAMILTON & COMPANY, engineers, 230, Berkeley Street, Glasgow, have granted a trust deed on behalf of their creditors in favour of Mr. John Wishart, 138, Bath Street, Glasgow.

ALFRED HERBERT, LIMITED, of Coventry, have been appointed sole agents for Great Britain and the Colonies for the plain grinding machines of the Norton Grinding Company, of Worcester, Mass., U.S.A.

THE COLTNESS IRON COMPANY, LIMITED, who recently acquired the Inshaw Tube Works, have been remodelling the works, and hope to have the new machinery in full operation very shortly.

MR. T. ROWLANDS, Banner Cross Road, Sheffield, who has recently returned from America, after an absence of three years, has been appointed agent for the Titanium Alloy Manufacturing Company.

AT a private meeting in London, recently, of the creditors of Andrew Handyside & Company, Limited, Britannia Ironworks, Derby, a committee of inspection was appointed, the shareholders having previously resolved that the company be voluntarily wound up.

THE first of a series of six lectures on "The Law Relating to Engineering" was delivered at Caxton Hall, Westminster, on Monday, October 10, under the auspices of the Society of Engineers (Incorporated) and the Junior Institution of Engineers. The lecturer was Mr. L. W. J. Costello.

THE NATIONAL STEEL FOUNDRY, LIMITED, have now almost completed their new works at Kirkland, Leven. The works, which were formerly occupied by the Scottish Cyanide Company, will consist of four departments adapted for the production of heavy and light castings and as finishing and engineering shops.

THE FOSTER ARC LAMP AND ENGINEERING COMPANY, LIMITED, have amalgamated with the Brockie-Pell Arc Lamp Company, and in future the two concerns will trade as the Foster Engineering Company, Limited. New works have lately been erected in Morden Road, Wimbledon, S.W.

IT is stated in the local papers that the capital of the company which proposes to erect new steel works at Barry is to be £200,000, for which arrangements have been made to underwrite £150,000. It is clear, however, that such a sum will not go very far. Those connected with the proposed enterprise do not offer any information.

BY an outbreak of fire which occurred at night recently in the foundry of Messrs. Smith & Hamilton, Coatdyke, Airdrie, the building, which was of considersize, was completely gutted, and a quantity of valuable patterns and machinery were damaged. The moulding shop, which bore the brunt of the outbreak, had just been reconstructed after its destruction by fire about three months ago.

ONE of the largest locomotives ever built in the United Kingdom is now under construction in the workshops of the Vulcan Foundry, Limited, at Newton-le-Willows, Lancashire. It is designed for hauling exceptionally heavy loads long distances over very hilly country, and is being built for the Mexican Railway Company. The weight of the engine, without the tender, is 140 tons.

AT Blantyre, new engineering works are being established. A beginning has been made with an extensive range of buildings, and ground acquired extending to 1½ acres at Craighead, adjoining the Hamilton to Glasgow line of the Caledonian Railway. The class of work to be undertaken by the new company is understood to be general colliery iron and steel work, structural and engineering work. It is hoped that actual manufacturing operations will be in progress by the end of the month.

GUTEHOFFNUNGSHUTTE, Oberhausen, Rheinland, Germany, have appointed Mr. James Turnbull, of 3, New Street, Birmingham, as technical sales engineer for the whole of Great Britain and Ireland. Mr. Turnbull will work in conjunction with the company's other British representatives, namely:—H. Wedekind, Limited, 110, Fenchurch Street, London, E.C.; Willock, Reid & Company, Limited, 109, Hope Street, Glasgow; H. H. Earle, Milburn House, Newcastle-on-Tyne.

THE VULCAN FOUNDRY, Darlaston, Staffs, formerly in the occupation of Messrs. W. H. Richards & Company, together with some three acres of land adjoining, has been purchased by Messrs. Wilkins & Mitchell, engineers and machinists, Bell Street, Darlaston. The foundry floor has been lowered some 3 ft., and is being laid out as a machine and erecting shop, and practically the whole of the machine tools will be built by the firm, who make a speciality of this work. A foundry for light castings is to be laid down adjoining the shop, and for this purpose the building will be removed from the Bell Street Works, which, when the change-over is completed, will be closed down.

MR. H. ADAMS has read an interesting paper before the Society of Engineers on "Current Professional Topics." In his opening remarks, the author referred to the fact that the status of the engineering profession had recently received considerable attention. He thought that the chief need is to prevent unqualified men from pretending that they are members of the profession, as by so doing they lower its prestige in the eyes of the general public. The author suggested the establishment of a central bureau where a register of the career of every engineer should be kept open to public inspection. Instead of applying for appointments as at present, a candidate would ask for a certified copy of his page in the register to be forwarded to a prospective employer. In the same way, before engaging an engineer an employer would obtain a copy of his record. Examinations to prove the competency of men to carry out certain duties should be as practical as possible, but candidates should show that they possess theoretical knowledge and know how to use it.

THE terms of the proposed amalgamation between the Birmingham Small Arms Company, Limited, and the Daimler Motor Company (1904), Limited, have been officially announced. The issued capital of the Daimler Company consists of 200,000 £1 ordinary shares and 80,880 6 per cent. preference shares, and in the event of reconstruction or amalgamation the preference shareholders were to be entitled to a premium of 25 per cent. The paid-up capital of the Birmingham Small Arms Company consists of 103,444 £5 ordinary and 40,630 preference shares. It is proposed that the Daimler shareholders shall receive 25s. for every £1 preference

share and any accrued interest, and for every four ordinary shares of £1 five fully paid-up £1 shares in the Small Arms Company, ranking pari passu with the ordinary shares of that company. A new Daimler Company is to be formed, the shares of which will be held entirely by the Birmingham Small Arms Company, who will take over all liabilities, subject to certain reservations. The Small Arms Company propose to sub-divide their £5 ordinary shares into £1 shares.

Deaths.

MR. J. SPENCER, of John Spencer & Company (Keighley), Limited, Atlas Machine Tool Works, Pitt Street, Keighley, died recently at the age of 70 years.

THE death is announced of Colonel W. H. Harfield, head of the firm of Messrs. Harfield & Company, engineers, Arundel House, Victoria Embankment, London, W.C.

COLONEL ALEXANDER GORDON, chairman of the Niles-Bement-Pond Company, and president of the Niles Tool Works Company, Hamilton, Ohio, U.S.A., died recently in London.

MR. J. W. B. MACLAREN, lately of the firm of Swan & MacLaren, engineers, Singapore, died suddenly at Edinburgh recently. Mr. McLaren only recently returned to this country.

MR. J. T. WARBURTON, who held a prominent position on the staff of A. Lees & Company, Limited, Soho Iron Works, Oldham, died recently, aged 69 years. He had been with the same firm for 53 years.

THE death has occurred of Mr. John Moncur, of Longcroft, Harrington, near Workington, who for many years was secretary and manager of the Distington Hematite Iron Company, Limited. He was 67 years of age.

MR. O. A. BODLEY died recently at his residence, Dunscombe, Magdalen Road, Exeter, aged 76 years. The deceased gentleman was connected with Messrs. Bodley Brothers & Company, Old Quay Foundry and Engine Works, Commercial Road, Exeter.

MR. J. P. COULTAS died at his residence, Horne House, Grantham, on October 3. He had been in failing health for some months. Deceased, who was born in 1845, was the eldest son of the late Mr. James Coultas, founder of the Perseverance Iron Works, Grantham.

THE death is announced from Hebburn-on-Tyne of Mr. Edward Marley, of the firm of Sproat, Marley & Company, Limited, iron and steel founders and engineers, Hebburn, co. Durham. Mr. Marley had for 20 years been a Justice of the Peace for Jarrow. He was about 60 years of age.

MR. JOHN FELL, of Flan How, Ulverston, died recently, after a lingering illness, in his 84th year. The deceased gentleman was one of the influential men who founded the present prosperity of Barrow-in-Furness. He had thrice been mayor of the borough, and was a director of the Barrow Hematite Steel Company, Limited, up to his death.

MR. ANDREW COOK, chairman and managing director of the old-established firm of William Cook & Sons, Limited, saw and file manufacturers, Glasgow and Sheffield, died at Dunblane recently. The deceased had been connected for many years with the business of which he was the head, being the last surviving son of the late Mr. William Cook, who died some four years ago.

MR. F. H. HARRISON, founder of the business now known as Harrison & Company (Lincoln), Limited, St. Mark's Lane, Lincoln, malleable iron and steel founders, died recently, at his residence, Whitehall, Lincoln, at the age of 74. Mr. Harrison, who was a native of Boston, went to Lincoln in his youth, and entered the offices of Messrs. Swan & Bourne, solicitors where he became managing clerk. He subsequently joined the late Mr. Henry Teague and Mr. J. Birch in starting the ironfoundry, which subsequently was converted into a limited liability company, with Mr. Harrison as chairman.

Personal.

THE late Mr. A. A. Hollingsworth, a director of Henry Bessemer & Company, Limited, left estate valued at £5,329 gross.

THE late Mr. S. Lucas, of the firm of E. Lucas & Son, ironfounders, Dronfield, left estate valued at £17,029 gross.

MR. G. CUTHBERT has been elected deacon and Mr. J. N. Bisset assessor of the Hammermen's Incorporation of Dundee.

MR. J. E. H. ALLBUT, secretary of the British Foundrymen's Association, has removed to "Meadow Lea," Highfield Road, Stretford, Manchester.

THE late Mr. Arthur Latch, engineer, of The Firs, Elvetham Road, Birmingham, who died on July 13, left estate valued at £47,590 gross, with net personalty £46,261.

MR. P. H. C. CHRIMES, of the firm of Messrs. Guest & Chrimes, engineers and brass founders, Rotherham, has been placed on the Commission of the Peace for the Borough of Scarborough.

THE late Major George Lopes, J.P., of Sandridge Park, Melksham, Wilts., a director of the Vulcan Foundry, Limited, left estate valued at £68,271 gross, with net personalty £52,368.

THE late Mr. Edward Kennard, D.L., J.P., of The Barn, Little Bowden, Northants, a director of the Blaenavon Company, Limited, aged 68 years, left estate valued at £80,710 gross, with net personalty £67,763.

MR. W. LORIMER, chairman of the North British Locomotive Company, Limited, and also of the Steel Company, of Scotland, Limited, was recently elected Deacon of the Hammermen of the Glasgow Incorporated Trades.

THE late Mr. R. Marriott, of Messrs. Marriott & Graham, Plantation Boiler Works, Govan, Glasgow, and a director of the London and Glasgow Engineering and Iron Shipbuilding Company, Limited, left personal estate in the United Kingdom valued at £60,456.

THE late Mr. William Whitwell, of Wm. Whitwell & Company, Limited, Thornaby Iron Works, Stockton-on-Tees, and a past-president of the Iron and Steel Institute, left estate valued at £53,984 gross, with net personalty £46,961.

MR. GEORGE MURE RITCHIE, chairman of the Millom and Askam Hematite Iron Company, Limited, and a director of the Cargo Fleet Iron Company, Limited, the Yorkshire Iron and Coal Company, Limited, and other concerns, has been elected a director of Palmers' Shipbuilding and Iron Company, Limited, in place of Admiral Cleveland, who recently resigned.

SIR ANDREW NOBLE, BART., K.C.B., who has been associated for 50 years with the Elswick Works of Sir W. G. Armstrong, Whitworth & Company, Limited, was presented recently with the freedom of the city of Newcastle-on-Tyne. It was announced later in the day that Sir Andrew Noble had handed to the Lord Mayor a cheque for £1,0000 to be employed to benefit some of the many good objects in which Sir William Stephenson took an interest. Sir Andrew has received an intimation that the King of Italy has conferred upon him the honour of the Grand Cross of the Crown of Italy.

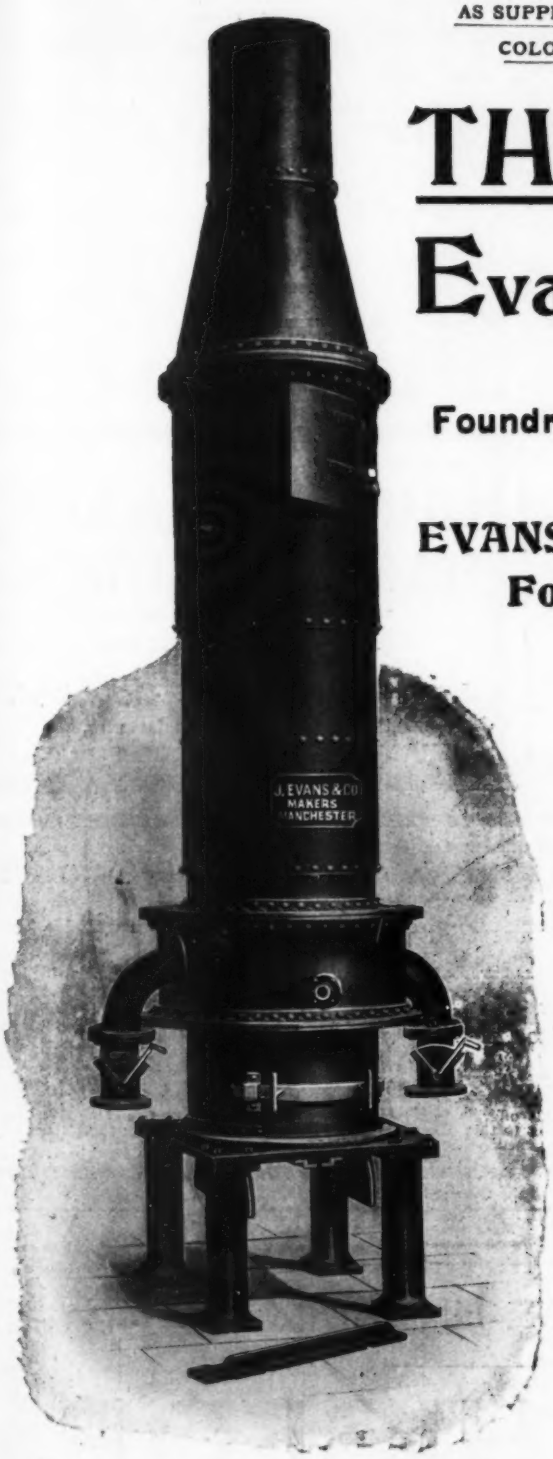
IT has been rumoured lately that Sir Charles McLaren, M.P., has resigned the chairmanship of Palmers' Shipbuilding and Iron Company, Limited, Jarrow. Although this report is not actually correct, we are informed by Mr. Victor Parker, secretary of the company, that it is true that Sir Charles for some time past has expressed a desire to retire from the chairmanship, and has expressed a wish that Lord Furness should occupy the position. This has been unanimously endorsed by the board of directors, and Lord Furness is now considering the question of occupying the chair.

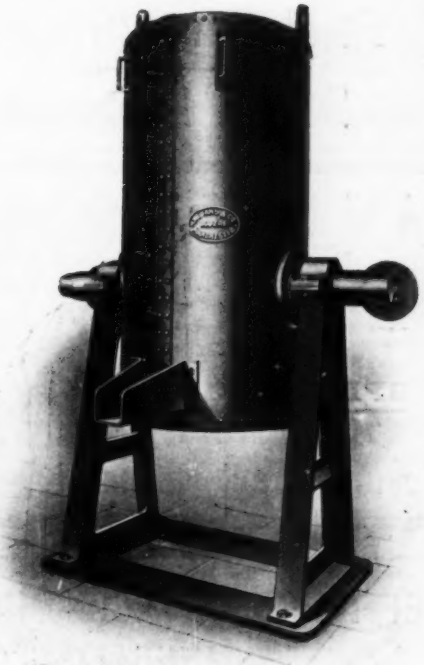
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

New Companies.

PROGRESSIVE ENGINEERING COMPANY, LIMITED.—Capital £500 in £1 shares.

APTHORPE & THOMSON, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc.

CARLTON ENGINEERING COMPANY, LIMITED.—Capital £6,000 in £1 shares. Registered office: Carlton House, Regent Street, W.

ADAIR, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of engineers, founders, etc. Registered office: 9, Eustace Street, Dublin.

CENTAUR TOOL WORKS, LIMITED.—Capital £10,000 in £1 shares, to acquire the business carried on by J. H. Petersen at 168-174, Bristol Street, Birmingham.

YORKSHIRE STEEL COMPANY, LIMITED.—Capital £5,000 in £1 shares (4,000 preference), to adopt an agreement with H. E. S. Holt. Registered office: 30, Holborn, E.C.

FRATELLI VECCHIATTI & COMPANY, LIMITED.—Capital £30,000 in £2 shares, to carry on the business of engineers, etc. Registered office: 70, Queen Victoria Street, E.C.

EPOCH SYNDICATE, LIMITED.—Capital £6,000 in £1 shares, to carry on the business of furnace, boiler and accessory makers, etc., and to develop and turn to account an invention referred to in an agreement with J. B. Kelloch.

INSTITUTE OF METALS.—Registered with 1,000 members, each liable for £1 in the event of winding up, to take over all or any of the assets and liabilities of the unincorporated society known as the Institute of Metals, and to adopt an agreement with G. Shaw Scott.

YORKSHIRE ENGINEERING COMPANY (EGYPT), LIMITED.—Capital £10,000 in £1 shares, to take over the business of a mechanical engineer, commission agent, etc., carried on by Mr. A. A. Fendian, at Cairo, Egypt. Registered office: Alexander Works, Ives Street, Shipley.

CHAS. HALL,

Foundry Requisite Maker,

DANTZIC ST., MANCHESTER.

Steel Wire Brushes.

Chaplets and Studs a Speciality.

Contractors to H.M. Government.

CHARCOAL, BLACKING, FOUNDRY COAL DUST,

Ground to any Mesh.

(As supplied to the Royal Arsenal, Woolwich.)

J. FIRMINGER & Co., Ltd.,

The Oldest Charcoal Manufacturers,

WALWORTH, LONDON, S.E.

ANALYSIS in the Foundry.

SPECIAL OFFER

to Readers of the

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Readers desiring analyses of:—

PIG-IRONS, CASTINGS, ALLOYS and all METALLURGICAL PRODUCTS

Should address their samples to

The Editor of the Foundry Trade Journal,
165, Strand, London, W.C.

Arrangements have been made for carrying out this work at the following low charges:—

PIG-IRON	Determination of	1 Constituent	£0 6 6
		5 Constituents	1 5 0
MOULDING SAND		1 Constituent	0 6 6
"		Complete Analysis	1 15 0
COKE		per Constituent	0 6 6
CUPOLA SLAG		"	0 6 6
" "		Complete Analysis	1 10 0

NOTE:—This offer is to subscribers only. Therefore unless the reader is a subscriber direct to this office, the name of the Agent supplying the "Journal" should be mentioned.

EFFICIENT AND ECONOMICAL HEATING OF FOUNDRY STOVES,
. . . ANNEALING OVENS, FURNACES, &c. . . .

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Gas Engineers, Underwood House, PAISLEY.

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

Prices and Particulars from

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ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, mor free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Navigation Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

Metals.	End Oct., 1910.	End Oct., 1909.
Iron—Scotch pig warrants ton	55/9	*57/0
—Middlesbro' warrants ton	49/11	51 4
—W.C. Mines Bessemer ... ton	66 6	62/6
—Stock, Scotch ... ... tons	1,000	1,000
Copper—Chili bars, GMB ton	£56 15 0	£56 17/6
—Stock, Europe and afloat tons	—	†96,612
Tin—English ingots ... ton	£163 10/0	£136 10/0
—Straits ... ... ton	£165 10/0	£137 17/6
—Stock, London, Holland, U.S.A., and afloat ...tons	—	22,025
Lead—English pig ... ton	£13 12 6	£13 10/0
Spelter—Ord. Silesian ... ton	£24 1 3	£23 5 0
Quicksilver (75lb)... bottle	£8 7/6	£8 7 6
Antimony—Regulus ton	£29 10/0-£30 0/0	£29 10/0

* Settlement price. † October 15.

Castings.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 0 0	to	3 5 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 7s. 6d.; all per ton f.o.b., London. Copper (clean), £54 10s. 0d.; brass (clean), £39 0s. 0d.; lead (usual draft), £12 5s. 0d.; tea lead, £11 5s. 0d.; zinc, £19 10s. 0d.; all per ton delivered merchant's yard.

Queries.

Facing Sands.

I should be pleased if any of your readers could give me mixings of facing sands, suitable for castings varying from 1 cwt. to 10 cwts. Any information concerning facing sands will be much esteemed.

"Novice."

Moulding Machines for Spur Wheels.

Could any reader give me information as to the best moulding machine for making spur wheels from wood and iron patterns, the sizes of wheels varying from 10 to 100 T, pitch 1 in.

"Interested."

Judge Shortt had before him, at Canterbury, last month, an application by William Henry Edwards, of 10, Theodore Terrace, Margate Road, Ramsgate, for his discharge in bankruptcy. At the time of filing his petition, the debtor was carrying on business as an iron and brass founder under the title of the Thanet Iron and Brass Foundry. The discharge was suspended for three years.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Ironfounders' Charcoal Blacking, Mineral Blacking, Coal & Coke Dust Manufacturer,
&c.
JAMES SYKES, HURST CHARCOAL MILL, Near ASHTON-UNDER-LYNE.
ESTABLISHED 1854.

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

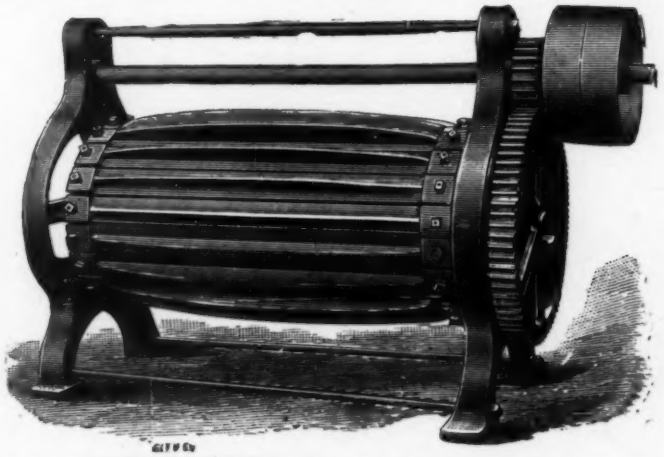
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

THAT'S GOOD ! !

We have heard this expression many times when showing Foundrymen this photo of one of the up-to-date foundries equipped by us. The sand is carried to the Moulding Machines by an overhead conveyor and is delivered into the moulding boxes by trays ; the operator shovels in the facing sand, that's all. The metal is brought to the men by the overhead runway shown, and the boxes are shaken out over the grating in the middle, under which is a conveyor which carries the sand back to the Sand Preparing Machines.

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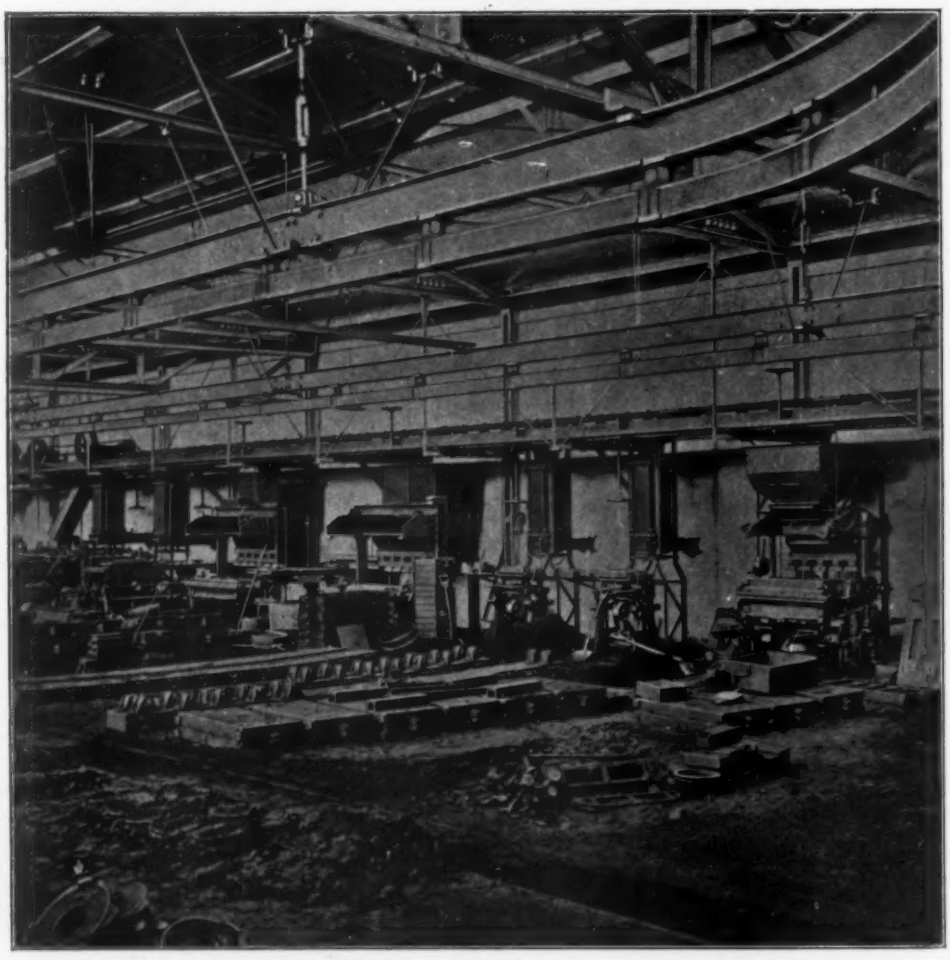

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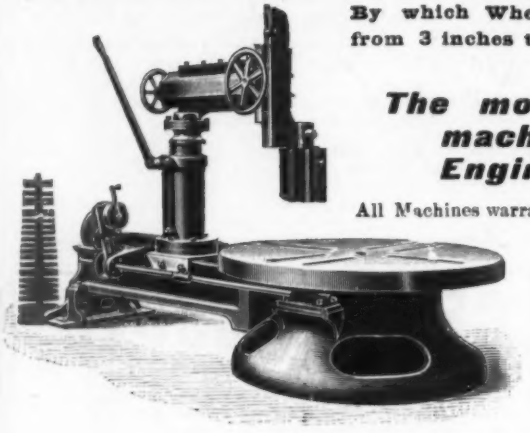

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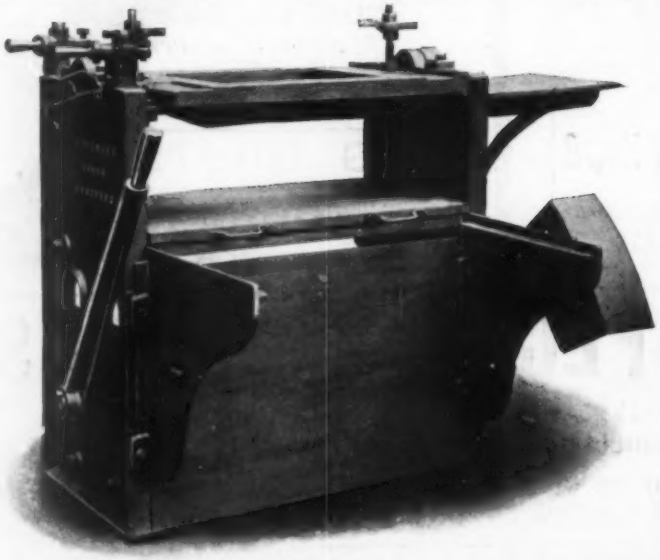

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628	McNeil, Chas.	Steel Ladles	Kinning Park, Glasgow	McNeil, Glasgow ...	X 155
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C. iii.	Plasti-Kon Co., The	Iron Cement	Caxton House, S.W.	—	—
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633	Thwaites Bros., Ltd.	Foundry Plant ...	Bradford	Thwaites, Bradford ..	325 Bradford
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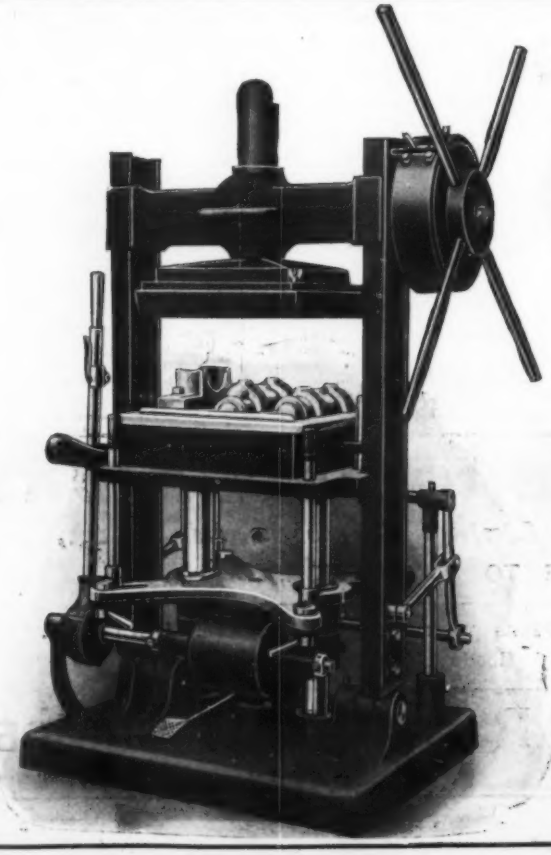

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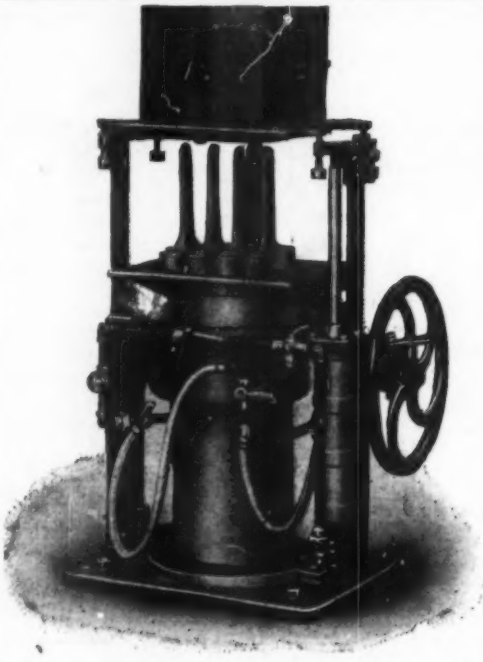

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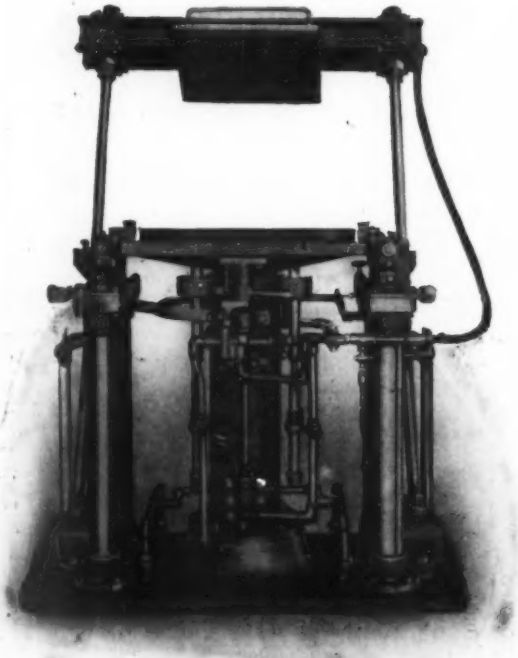

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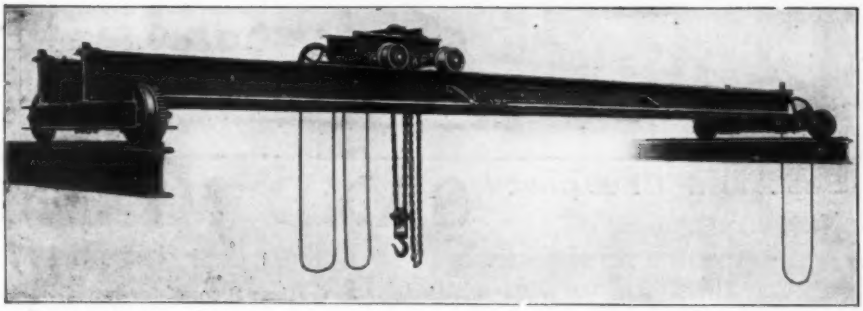

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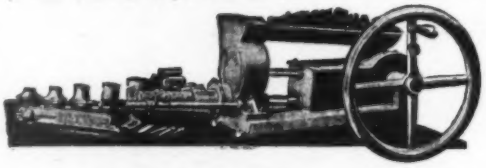

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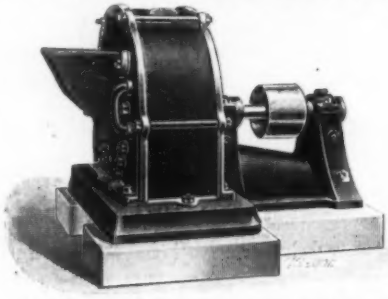

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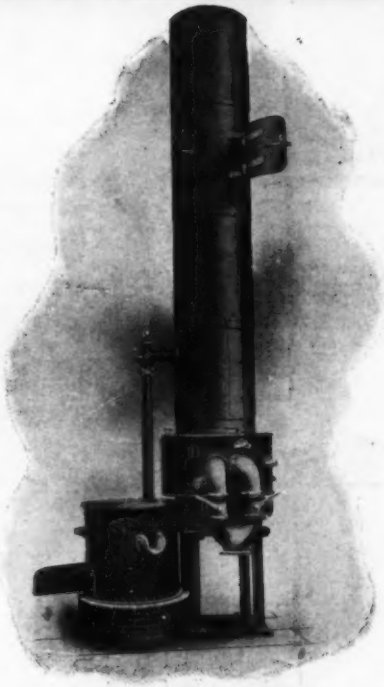

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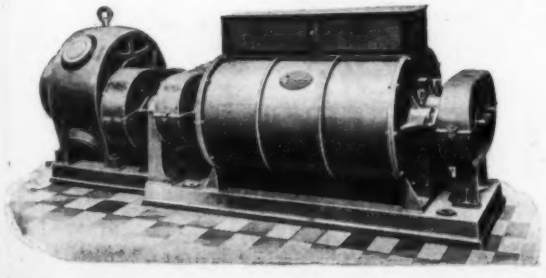

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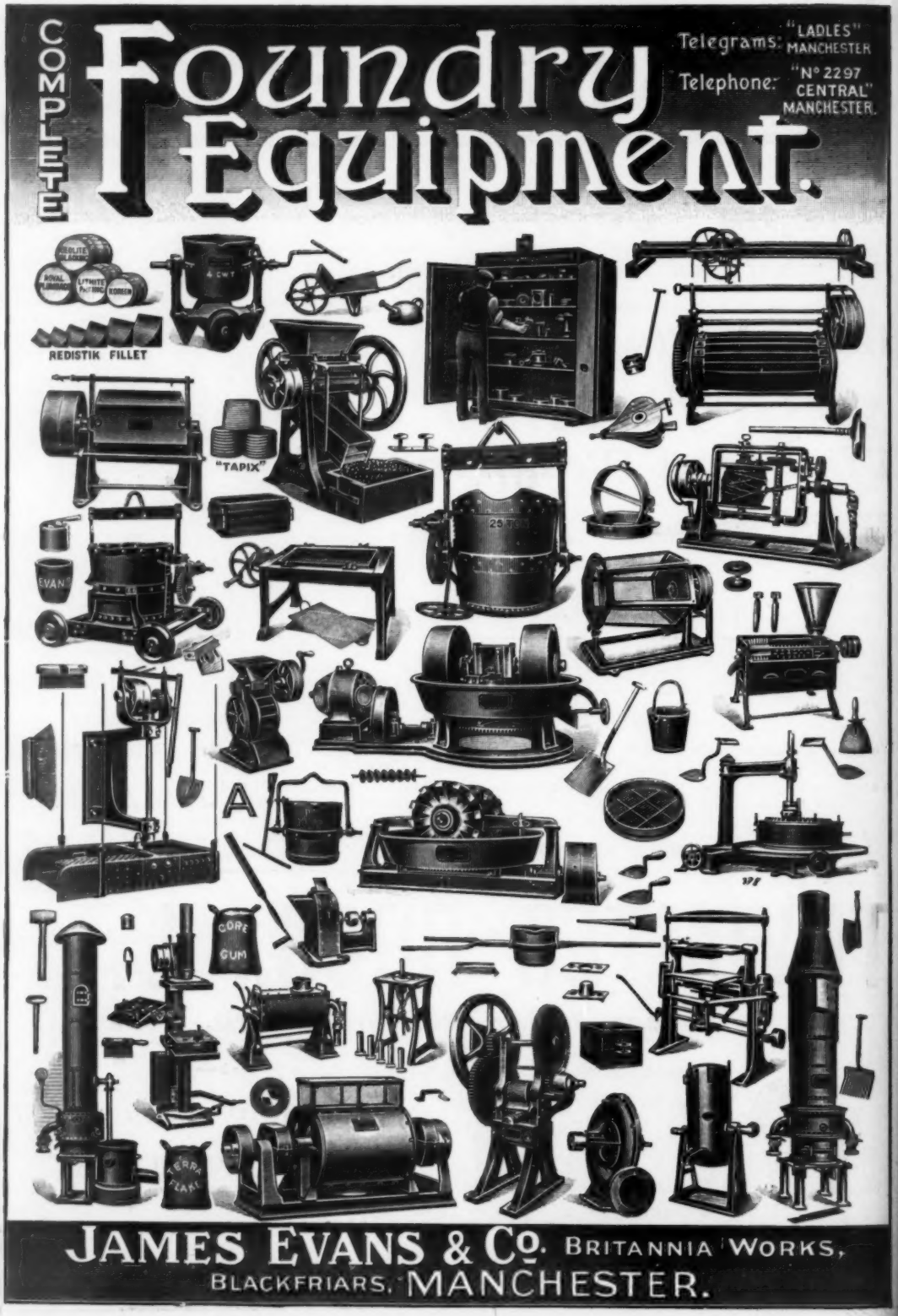
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